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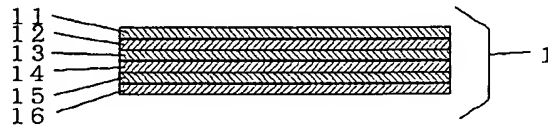
(54) 【発明の名称】 円偏光分離層、光学素子、偏光光源装置及び液晶表示装置

(57) 【要約】 *✓ Cholesteric*

【課題】 複数のコレステリック液晶層を重畳した場合の出射光の視角変化による色変化が少ない円偏光分離層を得て、側面からの入射光を効率よく出射する光利用効率に優れた偏光光源装置、及び明るくて視認性に優れた液晶表示装置を得ること。

【解決手段】 反射波長が異なる複数のコレステリック液晶層 (11, 13, 15) を、反射光の中心波長に基づいて長短の順序通りに重畳してなる円偏光分離層

(1)、及び側面からの入射光を上下面の一方より出射する導光板の出射面側に当該円偏光分離層を有する偏光光源装置。



## 【特許請求の範囲】

【請求項1】 反射波長が異なる複数のコレステリック液晶層を、反射光の中心波長に基づいて長短の順序通りに重畳したことを特徴とする円偏光分離層。

【請求項2】 請求項1において、反射光の中心波長が30～200nm相違する組合せで反射波長が青系、緑系又は赤系の3種のコレステリック液晶層を重畳したものである円偏光分離層。

【請求項3】 請求項1又は2において、コレステリック液晶層が支持基材上に付設されており、各コレステリック液晶層の合計厚が2～50μmで、支持基材を含む合計厚が20～200μmである円偏光分離層。

【請求項4】 請求項1～3に記載の円偏光分離層における最長波長のコレステリック液晶層側に位相差層又は偏光板の一方又は両方を有する光学素子。

【請求項5】 請求項4において、円偏光分離層と偏光板の間に位相差層が位置する光学素子。

【請求項6】 側面からの入射光を上下面の一方より出射する導光板の出射面側に、請求項1～3に記載の円偏光分離層又は請求項4若しくは5に記載の光学素子を有することを特徴とする偏光光源装置。

【請求項7】 液晶セルの片側に、請求項6に記載の偏光光源装置を配置したことを特徴とする液晶表示装置。

## 【発明の詳細な説明】

【0001】

【発明の技術分野】本発明は、コレステリック液晶層の視角による色変化を防止した円偏光分離層、及びそれを用いた光利用効率に優れた偏光光源装置、並びに明るさに優れて良視認性の液晶表示装置に関する。

【0002】

【背景技術】従来、側面よりの入射光を上下の片面より出射させるようにしたサイドライト型の導光板の下面に反射層を設け、出射面にコレステリック液晶層からなる円偏光分離層を設けて、その円偏光分離層を介し入射光を左右の円偏光からなる透過光と反射光に分離し、その反射光を下面の反射層を介し反射させて出射面より再出射させるようにした照明システムが提案されていた（特開平3-45906号公報、特開平6-324333号公報、特開平7-36032号公報）。

【0003】かかる照明システムは、非偏光の通例光では偏光板を透過する際に導光板出射光の55%程度が吸収されて有効利用できる光に乏しいことから、光を偏光として偏光板に供給できるようにして偏光板による吸収を防止し、それにより光利用効率の向上をはかって液晶表示装置等の明るさを向上させることを目的としたものである。前記の円偏光分離層を介した反射光の波長(λ)は、入射角をθとしたとき、コレステリック液晶層の複屈折による常光と異常光の屈折率(n<sub>o</sub>、n<sub>e</sub>)及び螺旋ピッチ(p)に基づき、式：n<sub>o</sub>p cosθ < λ < n<sub>e</sub>p cosθで表される。

【0004】前記のn<sub>o</sub>、n<sub>e</sub>は大きい値でないことから通例、反射光の波長領域は可視光領域よりも狭く、単層のコレステリック液晶層を介した透過光及び反射光が色付いて見え、選択反射性や円偏光二色性と称されている。厚さ方向にコレステリック液晶層のピッチを変えて反射光の波長領域を広げる試みもあるが（特開平6-281814号公報）、一般には反射光の波長領域の異なる複数のコレステリック液晶層を重畳した円偏光分離層として、前記着色を中間色化する方法が採られている（特開平1-133003号公報）。

【0005】しかしながら、前記した重畳型の円偏光分離層には、視角を変える際に射出光が青色化し、更に視角を変えると赤色化するという色変化の問題点があった。円偏光分離層をバックライトシステムとして液晶表示装置に適用した場合、表示色が青色側にシフトし、そのため発光体の輝線スペクトル波長を円偏光分離層による反射波長の中心とその短波長端の間に設定する提案もあるが（特開平7-36025号公報）、前記の視角変化による色変化の解決策とはならない。

【0006】

【発明の技術的課題】本発明は、複数のコレステリック液晶層を重畳した場合の出射光の視角変化による色変化が少ない円偏光分離層を得て、側面からの入射光を効率よく出射する光利用効率に優れた偏光光源装置、及び明るくて視認性に優れた液晶表示装置を得ることを課題とする。

【0007】

【課題の解決手段】本発明は、反射波長が異なる複数のコレステリック液晶層を、反射光の中心波長に基づいて長短の順序通りに重畳したことを特徴とする円偏光分離層、及び側面からの入射光を上下面の一方より出射する導光板の出射面側に当該円偏光分離層を有することを特徴とする偏光光源装置を提供するものである。

【0008】

【発明の効果】複数のコレステリック液晶層を反射波長の長短の順序通りに重畳した上記の構成により、視角変化による射出光の色変化が小さい円偏光分離層を得ることができ、それを用いて光利用効率に優れた偏光光源装置、ひいては明るくて視認性に優れた液晶表示装置を得ることができる。視角変化で射出光が色変化する理由は、円偏光分離層を偏光として透過するためであるかも知れないが定かではなく、従って前記の重畳方式で視角変化による色変化が抑制される理由は不明である。

【0009】

【発明の実施形態】本発明の円偏光分離層は、反射波長が異なる複数のコレステリック液晶層を、反射光の中心波長に基づいて長短の順序通りに重畳したものである。その例を図1に示した。1が円偏光分離層であり、11、13、15がコレステリック液晶層、12、14、16が支持基材である。

【0010】コレステリック液晶層としては、グランジャン配向により自然光を透過光と反射光として左右の円偏光に分離する適宜なものを用いる。ちなみにその具体例としては、コレステリック液晶相を有する層、就中コレステリック相を呈する液晶ポリマーからなる層を有するシートや当該層をガラス板等の上に展開したシート、あるいはコレステリック相を呈する液晶ポリマーからなるフィルムなどがあげられる。

【0011】前記においてコレステリック液晶層は、可及的に均一に配向していることが好ましい。均一配向のコレステリック液晶層は、散乱のない反射光を提供して、液晶表示装置等の視野角の拡大に有利であり、特に斜め方向からも直接観察される直視型液晶表示装置等の形成に適している。

【0012】本発明による円偏光分離層は、反射波長が異なる複数のコレステリック液晶層を、反射光の中心波長に基づいて長短の順序通りに2層又は3層以上を重ねることにより形成することができる。かかるコレステリック液晶層の重畳化は、分離機能の広波長域化を目的とする。

【0013】すなわち、単層のコレステリック液晶層では通例、選択反射性(円偏光二色性)を示す波長域に限界があり、その限界は約100nmの波長域に及ぶ広い範囲の場合もあるが、その波長範囲でも液晶表示装置等に適用する場合に望まれる可視光の全域には及ばないから、そのような場合に選択反射性(反射波長)の異なるコレステリック液晶層を重ねさせて円偏光二色性を示す波長域を拡大させることを目的とする。

【0014】ちなみに、選択反射の中心波長が300~900nmの範囲にあるコレステリック液晶層を同じ方向の円偏光を反射する組合せで、かつ選択反射の中心波長が異なる組合せ、就中それぞれ30~200nm異なる組合せで用いて、その2~6種類を重ねることで可視光域等の広い波長域をカバーできる円偏光分離層を効率的に形成することができる。特に可視光用としては、反射波長が青系統と緑系統と赤系統の3種のコレステリック液晶層を重ねたものが、少ない重畳数による薄型化などの点より好ましい。

【0015】前記した同じ偏光方向の円偏光を反射するもの同士の組合せで重畳物とする点は、各層で反射される円偏光の位相状態を揃えて各波長域で異なる偏光状態となることを防止し、利用できる状態の偏光の増量を目的とする。

【0016】円偏光分離層を形成するコレステリック液晶には、適宜なものを用いてよく、特に限定はない。従って、液晶配向性を付与する共役性の直線状原子団(メソゲン)がポリマーの主鎖や側鎖に導入された主鎖型や側鎖型などの種々のものを用いる。位相差の大きいコレステリック液晶分子ほど選択反射の波長域が広くなり、層数の軽減や大視野角時の波長シフトに対する余裕

などの点より好ましく用いる。また重さや自立性等の点よりは液晶ポリマーが好ましく用いる。さらに、その液晶ポリマーとしては、取扱い性や実用温度での配向の安定性などの点より、ガラス転移温度が30~150℃のものが好ましく用いる。

【0017】ちなみに、前記した主鎖型の液晶ポリマーの例としては、屈曲性を付与するスペーサ部を必要に応じ介してパラ置換環状化合物等からなるメソゲン基を結合した構造を有する、例えばポリエステル系やポリアミド系、ポリカーボネート系やポリエステルイミド系などのポリマーがあげられる。

【0018】また側鎖型の液晶ポリマーの例としては、ポリアクリレートやポリメタクリレート、ポリシロキサンやポリマロネート等を主鎖骨格とし、側鎖として共役性の原子団からなるスペーサ部を必要に応じ介してパラ置換環状化合物等からなる低分子液晶化合物(メソゲン部)を有するもの、低分子カイラル剤含有のネマチック系液晶ポリマー、キラル成分導入の液晶ポリマー、ネマチック系とコレステリック系の混合液晶ポリマーなどがあげられる。

【0019】前記の如く、例えばアゾメチン形やアゾ形、アゾキシ形やエステル形、ビフェニル形やフェニルシクロヘキサン形、ビシクロヘキサン形の如きパラ置換芳香族単位やパラ置換シクロヘキシル環単位などからなるネマチック配向性を付与するパラ置換環状化合物を有するものにも、不斉炭素を有する化合物等からなる適宜なキラル成分や低分子カイラル剤等を導入する方式などによりコレステリック配向性のものとすることができる(特開昭55-21479号公報、米国特許明細書第5332522号等)。なおパラ置換環状化合物におけるパラ位における末端置換基は、例えばシアノ基やアルキル基、アルコキシ基などの適宜なものであってよい。

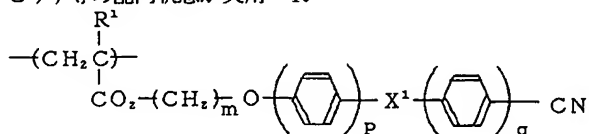
【0020】またスペーサ部としては、屈曲性を示す例えばポリメチレン鎖 $-(CH_2)_n-$ やポリオキシメチレン鎖 $-(CH_2CH_2O)_m-$ などがあげられる。スペーサ部を形成する構造単位の繰返し数は、メソゲン部の化学構造等により適宜に決定され、一般にはポリメチレン鎖の場合にはnが0~20、就中2~12、ポリオキシメチレン鎖の場合にはmが0~10、就中1~3である。

【0021】なお上記した主鎖型液晶ポリマーの調製は例えば、成分モノマーをラジカル重合方式やカチオン重合方式やアニオン重合方式等により共重合させる、通例のポリマー合成に準じた適宜な方式で行うことができる。また側鎖型液晶ポリマーの調製も例えば、アクリル酸やメタクリル酸のエステルの如きビニル系主鎖形成用モノマーに必要な応じスペーサ基を介してメソゲン基を導入したモノマーをラジカル重合法等によりポリマー化するモノマー付加重合方式や、ポリオキシメチルシリレンのSi-H結合を介し白金系触媒の存在下にビニル置

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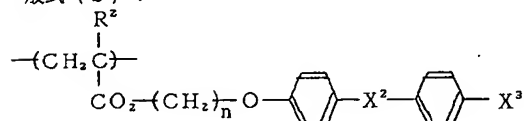
換メソゲンモノマーを付加反応させる方式、主鎖ポリマーに付与した官能基を介し相関移動触媒を用いたエステル化反応によりメソゲン基を導入する方式や、マロン酸の一部に必要に応じスペーサ基を介してメソゲン基を導入したモノマーとジオールとを重縮合反応させる方式などの適宜な方式で行うことができる。

【0022】上記において、成膜性及良好なモノドメイン状態のグランジャン配向性、配向処理の短時間性やガラス状態への安定した固定性、コレステリック相の螺旋ピッチの制御性、薄くて軽くピッチ等の配向状態が実用\* 10

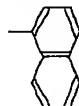
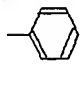


(ただし、 $R^1$ は水素又はメチル基、 $m$ は1~6の整数、 $X^1$ は $CO_2$ 基又は $OCO$ 基であり、 $p$ 及び $q$ は1又は2で、かつ $p+q=3$ を満足する。)

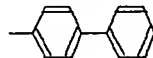
一般式(b):



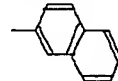
(ただし、 $R^2$ は水素又はメチル基、 $n$ は1~6の整数、



※ であり、 $R^5$ は下記のものである。)



又は



【0024】前記の一般式(a)、一般式(b)で表わされるモノマー単位を形成しうるアクリル系モノマーは、適宜な方法で合成することができる。その例としては、先ずエチレンクロロヒドリンと4-ヒドロキシ安息香酸を、ヨウ化カリウムを触媒としてアルカリ水溶液中で加熱還流させてヒドロキシカルボン酸を得た後、それをアクリル酸又はメタクリル酸と脱水反応させて(メタ)アクリレートとし、その(メタ)アクリレートを4-シアノ-4'-ヒドロキシビフェニルでDCC(ジシクロヘキシルカルボジイミド)とDMAP(ジメチルアミノピリジン)の存在下にエステル化することにより一般式(a)に属するモノマーを得る方法があげられる。

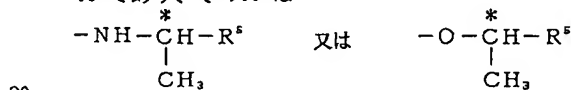
【0025】また、一般式(b)に属するアクリル系モノマーの合成例としては、先ずヒドロキシアルキルハライドと4-ヒドロキシ安息香酸を、ヨウ化カリウムを触媒としてアルカリ水溶液中で加熱還流させてヒドロキシカルボン酸を得た後、それをアクリル酸又はメタクリル酸と脱水反応させて(メタ)アクリレートとしその(メタ)アクリレートを、4位に $R^3$ 基含有のCO基を有するフェノールでDCCとDMAPの存在下にエステル化する方法や、前記の脱水反応後その(メタ)アクリレー

6

\* 温度で変化しにくく、耐久性や保存安定性に優れた円偏光分離層の形成性などの点より好ましく用いうる液晶ポリマーは、下記的一般式(a)で表わされるモノマー単位と、一般式(b)で表わされるモノマー単位を成分とする共重合体、就中、一般式(a)のモノマー単位60~95重量%と、一般式(b)のモノマー単位40~5重量%からなる共重合体を成分とするものである(特願平7-251818号)。

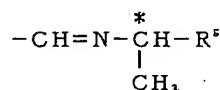
【0023】一般式(a):

※数、 $X^2$ は $CO_2$ 基又は $OCO$ 基、 $X^3$ は $-CO-R^3$ 又は $-R^4$ であり、その $R^3$ は

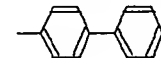


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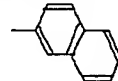
$R^4$ は



※



又は



30★トを4位に不斉炭素基を有するフェノールでDCCとDMAPの存在下にエステル化する方法などがあげられる。

【0026】従って、前記の一般式(a)や一般式(b)に属する他のモノマーも、目的の導入基を有する適宜な原料を用いて上記に準じて合成することができる。なお前記の4位に $R^3$ 基含有のCO基を有するフェノールは、例えば先ずクロロ蟻酸メチルと4-ヒドロキシ安息香酸をアルカリ水溶液中で反応させてカルボン酸とし、それをオキサリルクロリドで酸クロライドとした後、ピリジン/テトラヒドロフラン中で $H-R^3$ と反応させて $R^3$ 基を導入し、ついでそれをアンモニア水で処理して保護基を除去する方法などにより、また4位に不斉炭素基を有するフェノールは、例えば4-ヒドロキシベンズアルデヒドと(S)-(-)-1-フェニルエチルアミンをトルエン中で共沸脱水する方法などにより得ることができる。

【0027】上記した共重合体は、その一般式(b)で表わされるモノマー単位の含有率を変えることでコレステリック液晶の螺旋ピッチを変化させることができる。従って、一般式(b)で表わされるモノマー単位の含有

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率の制御で円偏光二色性を示す波長を調節でき、可視光域の光に対して円偏光二色性を示す光学素子も容易に得ることができる。

【0028】液晶ポリマーによるコレステリック液晶層の形成は、従来の配向処理に準じた方法で行うことができる。ちなみにその例としては、支持基材上にポリイミドやポリビニルアルコール、ポリエステルやポリアリレート、ポリアミドイミドやポリエーテルイミド等の膜を形成してレーヨン布等でラビング処理した配向膜、又はSiO<sub>2</sub>の斜方蒸着層、又は延伸処理による配向膜等からなる適宜な配向膜の上に液晶ポリマーを展開してガラス転移温度以上、等方相転移温度未満に加熱し、液晶ポリマー分子がランダム配向した状態でガラス転移温度未満に冷却してガラス状態とし、当該配向が固定化された固化層を形成する方法などがあげられる。

【0029】前記の支持基材としては、例えばトリアセチルセルロースやポリビニルアルコール、ポリイミドやポリアリレート、ポリエステルやポリカーボネート、ポリスルホンやポリエーテルスルホン、アモルファスポリオレフィンや変性アクリル系ポリマー、エポキシ系樹脂の如きプラスチックからなる単層又は積層フィルム、あるいはガラス板などの適宜なものを用いる。薄型化等の点よりは、プラスチックフィルムが好ましく、また偏光状態の変化の防止による光の利用効率の向上などの点よりは複屈折による位相差が可及的に小さいものが好ましい。

【0030】液晶ポリマーの展開は、例えば液晶ポリマーの溶媒による溶液をスピンコート法やロールコート法、フローコート法やプリント法、ディップコート法や流延成膜法、バーコート法やグラビア印刷法等の適宜な方法で薄層展開し、それを必要に応じて乾燥処理する方法などにより行うことができる。前記の溶媒としては、例えば塩化メチレンやシクロヘキサノン、トリクロロエチレンやテトラクロロエタン、N-メチルピロリドンやテトラヒドロフランなどの適宜なものを用いる。

【0031】また液晶ポリマーの加熱溶融物、好ましくは等方相を呈する状態の加熱溶融物を前記に準じ展開し、必要に応じその溶融温度を維持しつつ更に薄層に展開して固化させる方法などの、溶媒を使用しない方法、従って作業環境の衛生性等が良好な方法によっても液晶ポリマーを展開させることができる。なお液晶ポリマーの展開に際しては、薄型化等を目的に必要に応じて配向膜を介したコレステリック液晶層の重畳方式なども採ることができる。

【0032】液晶ポリマーの展開層を配向させるための加熱処理は、上記した如く液晶ポリマーのガラス転移温度から等方相転移温度までの温度範囲、すなわち液晶ポリマーが液晶相を呈する温度範囲に加熱することにより行うことができる。また配向状態の固定化は、ガラス転移温度未満に冷却することで行うことができ、その冷却

条件については特に限定はない。通例、前記の加熱処理を300℃以下の温度で行いことから、自然冷却方式が一般に採られる。

【0033】支持基材上に形成した液晶ポリマーの固化層は、支持基材との一体物としてそのまま円偏光分離層に用いるし、支持基材より剥離してフィルム等からなる円偏光分離層として用いることもできる。フィルム等からなる支持基材との一体物として形成する場合には、偏光の状態変化の防止性などの点より、位相差が可及的に小さい支持基材を用いることが好ましい。

【0034】コレステリック液晶層の厚さは、配向の乱れや透過率低下の防止、選択反射の波長範囲の広さなどの点より、0.5〜50μm、就中1〜30μm、特に2〜10μmが好ましい。また円偏光分離層の薄型化等の点より各コレステリック液晶層の合計厚が2〜50μm、就中3〜30μm、特に5〜10μmであることが好ましい。さらに支持基材を有する場合には、その基材を含めた合計厚が20〜200μm、就中25〜150μm、特に30〜100μmであることが好ましい。円偏光分離層の形成に際しては、コレステリック液晶層に安定剤や可塑剤、あるいは金属類などからなる種々の添加剤を必要に応じて配合することができる。

【0035】本発明において用いる円偏光分離層は、例えば低分子量体からなるコレステリック液晶層をガラスやフィルム等の透明基材で挟持したセル形態、液晶ポリマーからなるコレステリック液晶層を透明基材で支持した形態、コレステリック液晶層の液晶ポリマーのフィルムからなる形態、それらの形態物を適宜な組合せて重畳した形態などの適宜な形態とすることができる。

【0036】前記の場合、コレステリック液晶層をその強度や操作性などに応じて1層又は2層以上の支持基材で保持することもできる。2層以上の支持基材を用いる場合には、偏光の状態変化を防止する点などより例えば無配向のフィルムや、配向しても複屈折の小さいトリアセテートフィルムなどの如く位相差が可及的に小さいものが好ましく用いる。薄型化等の点より好ましい形態は、透明基材で支持した形態や液晶ポリマーのフィルムからなる形態などである。

【0037】なお円偏光分離層は、上記の分離性能の均一化や斜め入射光の波長シフトに対処する点などより重畳の各層は、平坦な層として形成されていることが好ましい。コレステリック液晶層の重畳には、製造効率や薄膜化などの点より液晶ポリマーの使用が特に有利である。重畳処理は、単なる重ね置きや、粘着剤等の接着剤を介した接着などの適宜な方式を採ることができる。

【0038】本発明においては、円偏光分離層の光出射側となる最長波長のコレステリック液晶層側に、位相差層や偏光板や拡散層等の適宜な光学層の1種又は2種以上を配置して種々の光学素子を形成することができる。その例を図2、図3に示した。2が位相差層、3が偏光

板である。

【0039】位相差層は、直線偏光変換手段として機能するものであり、円偏光分離層より出射した円偏光が位相差層に入射して位相変化を受け、その位相変化が $1/4$ 波長に相当する波長の光は直線偏光に変換され、他の波長光は楕円偏光に変換される。変換された楕円偏光は、前記の直線偏光に変換された光の波長に近いほど扁平な楕円偏光となる。かかる結果、偏光板を透過しうる直線偏光成分を多く含む状態の光が位相差層より出射されることとなる。

【0040】直線偏光成分の多い状態に変換することにより、偏光板を透過しやすい光とすることができる。この偏光板は、例えば液晶表示装置の場合、液晶セルに対する視野角の変化で発生する偏光特性の低下を防止して表示品位を維持する光学層や、より高度な偏光度を実現してよりよい表示品位を達成する光学層などとして機能するものである。

【0041】すなわち前記において、偏光板を用いずに、円偏光分離層よりの出射偏光をそのまま液晶セルに入射させて表示を達成することは可能であるが、偏光板を介することで前記した表示品位の向上等をはかりうることから必要に応じて偏光板が用いられる場合がある。その場合に、偏光板に対する透過率の高いほど表示の明るさの点より有利であり、その透過率は偏光板の偏光軸（透過軸）と一致する偏光方向の直線偏光成分を多く含むほど高くなるので、それを目的に直線偏光変換手段を介して円偏光分離層よりの出射偏光を所定の直線偏光に変換するものである。

【0042】ちなみに、通例のヨウ素系偏光板に自然光や円偏光を入射させた場合、その透過率は約43%程度であるが、直線偏光を偏光軸を一致させて入射させた場合には80%を超える透過率を得ることができ、従って光の利用効率が大幅に向上して明るさに優れる液晶表示などが可能となる。またかかる偏光板では、99.99%に達する偏光度も達成できる。円偏光分離層の単独では、かかる高偏光度の達成は困難で、特に斜めからの入射光に対する偏光度が低下しやすい。

【0043】位相差層としては、円偏光分離層より出射した円偏光を、 $1/4$ 波長の位相差に相当して直線偏光を多く形成しうると共に、他の波長の光を前記直線偏光と可及的に平行な方向に長径方向を有し、かつ可及的に直線偏光に近い扁平な楕円偏光に変換しうるものが好ましい。位相差層は、円偏光分離層と共に偏光板と一体的に設けることもできる。

【0044】前記の如き位相差層を用いることにより、その出射光の直線偏光方向や楕円偏光の長径方向が偏光板の透過軸と可及的に平行になるように配置して、偏光板を透過しうる直線偏光成分の多い状態の光を得ることができる。位相差層は、適宜な材質で形成でき、透明で均一な位相差を与えるものが好ましく、一般には位相差

板が用いられる。

【0045】位相差層にて付与する位相差は、円偏光分離層より出射される円偏光の波長域などに応じて適宜に決定しうる。ちなみに可視光域では波長範囲や変換効率等の点より、殆どの位相差板がその材質特性より正の複屈折の波長分散を示すものであることも加味して、その位相差が小さいもの、就中100~180nm、特に110~150nm以下の位相差を与えるものが好ましく用いうる。

10 【0046】位相差板は、1層又は2以上の重畳層として形成することができる。1層からなる位相差板の場合には、複屈折の波長分散が小さいものほど波長毎の偏光状態の均一化をはかることができて好ましい。一方、位相差板の重畳化は、波長域における波長特性の改良に有効であり、その組合せは波長域などに応じて適宜に決定してよい。

【0047】なお可視光域を対象に2層以上の位相差板とする場合、上記の如く100~180nmの位相差を与える層を1層以上の奇数層として含ませることが直線偏光成分の多い光を得る点より好ましい。100~180nmの位相差を与える層以外の層は、通例200~400nmの位相差を与える層で形成することが波長特性の改良等の点より好ましいが、これに限定するものではない。

【0048】位相差板は、例えばポリカーボネートやポリスルホン、ポリエステルやポリメチルメタクリレート、ポリアミドやポリビニールアルコール等からなるフィルムを延伸処理してなる複屈折性シートなどとして得ることができる。発光強度や発光色を広い視野角で均一に維持する点よりは、位相差層の面内における位相差の誤差が小さいほど好ましく、就中、その誤差が $\pm 10$ nm以下であることが好ましい。

30 【0049】位相差層に設定する位相差や光学軸の方向は、目的とする直線偏光の振動方向などに応じて適宜に決定することができる。ちなみに135nmの位相差を与える位相差層の場合、円偏光の向きに応じて光学軸に対し振動方向が+45度又は-45度の直線偏光（波長540nm）が得られる。なお位相差層が2層以上からなる場合、特にその外部側表面層を100~180nmの位相差を与える層が占める場合にはその層に基づいて配置角度を設定することが好ましい。

40 【0050】円偏光分離層の所定側に上記した直線偏光変換手段としての位相差層を設けた場合には、図3に例示の如くその位相差層の上に必要に応じて偏光板が設けられる。かかる形態の光学素子は、その偏光板を液晶セルの光源側の偏光板として用いることができる。また偏光板は、円偏光分離層の所定側に位相差層を設けることなく配置することもできる。かかる形態の光学素子は、円偏光分離層を透過した円偏光を偏光板を介して直線偏光化するようにしたものであり、液晶セルの光源側に好ましく用いうる。

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【0051】偏光板としては、適宜なものを用いるが一般には、偏光フィルムからなるものが用いられる。偏光フィルムの例としては、ポリビニルアルコール系や部分ホルマール化ポリビニルアルコール系、エチレン・酢酸ビニル共重合体系部分ケン化物の如き親水性高分子のフィルムにヨウ素及び／又は二色性染料を吸着させて延伸したもの、ポリビニルアルコールの脱水処理物やポリ塩化ビニルの脱塩酸処理物の如きポリエン配向フィルムなどがあげられる。偏光フィルムの厚さは通例5～80  $\mu\text{m}$ であるが、これに限定されない。用いる偏光板は、

偏光フィルムの片面又は両面を透明保護層等で被覆したものなどであってもよい。  
【0052】円偏光分離層に必要に応じて設ける拡散層は、導光板と共に使用した場合に出射光を平準化して明暗ムラを抑制し、液晶セルに適用した場合に画素との干渉でモアレによるギラギラした視認が生じることの防止などを目的とする。円偏光分離層より出射した光の偏光状態の維持性などの点より好ましく用いる拡散層は、位相差が波長633nmの垂直入射光、好ましくは入射角30度以内の入射光に基づいて30nm以下、就中0～20nmのものである。

【0053】拡散層は、例えば粒子分散樹脂層の形成方式、サンドブラストや化学エッチング等の表面凹凸化処理による方式、機械的ストレスや溶剤処理等によるクレイズ発生方式、所定の拡散構造を設けた金型による転写形成方式などの任意な方式で、円偏光分離層や位相差層等への塗布層や拡散シートなどとして適宜に形成することができる。なお拡散層は、円偏光分離層の最短波長側や最長波長側、円偏光分離層に設けた位相差層や偏光板の間や、それらの上面などの適宜な位置に配置することができる。

【0054】本発明による偏光光源装置は、側面からの入射光を上下面の一方より出射する導光板の出射面側に、上記した円偏光分離層又は光学素子を配置したものである。その例を図4に例示した。4が導光板である。かかる偏光光源装置によれば、導光板より出射した光が円偏光分離層に入射し、左右いずれかの円偏光は透過し、他方の円偏光は反射され、その反射光は、戻り光として導光板に再入射する。導光板に再入射した光は、下面の反射層等からなる反射機能部分で反射されて再び円偏光分離層に入射し、透過光と反射光（再々入射光）に再度分離される。

【0055】従って、反射光としての再入射光は、円偏光分離層を透過しうる所定の円偏光となるまで円偏光分離層と導光板との間に閉じ込められて反射を繰返すこととなるが、本発明においては再入射光の利用効率等の点より、可及的に少ない繰返し数で、就中、初回の再入射光が反射の繰返しなく出射するようにしたものが好ましい。

【0056】前記の導光板としては、側面からの入射光

を上下面の一方より出射する適宜なものを用いる。導光板は通例、いずれか一方が出射面となる上下面、及び上下面間の少なくとも一側端面からなる入射面を有する板状物からなる。円偏光分離層を介して再入射した円偏光を位相差の影響なくその円偏光状態を良好に維持したまま下面に導き、また下面で反射した帰路光をその円偏光状態を維持したまま出射させる点などより好ましく用いる導光板は、厚さ方向における複屈折による位相差が上記した拡散層と同様に可及的に小さいものであり、就中30nm以下、特に0～20nmのものである。

【0057】導光板の形態は、出射面よりの出射効率に優れその出射光が出射面に対する垂直性に優れて有効利用しやすく、また円偏光分離層を介した再入射光の出射効率にも優れてその出射方向の初期出射方向との近似性などの点より、微細なプリズム状凹凸、就中、長辺面と短辺面からなる凸部又は凹部を周期的に有する構造が好ましい（特願平7-321036号）。さらに入射面に対向する側端面の厚さが入射面のそれよりも薄いもの、就中50%以下の厚さであるものが好ましい。

【0058】前記の入射面に対する対向側端面の薄型化は、入射面より入射した光が伝送端としての当該対向側端面に至るまでに、プリズム状凹凸面の短辺面に効率よく入射し、その反射を介し出射面より出射して入射光を目的面に効率よく供給できる点で有利である。またかかる薄型化構造とすることで導光板を軽量化でき、例えばプリズム状凹凸面が直線状の場合、均一厚の導光板の約75%の重量とすることができる。

【0059】前記したプリズム状凹凸を形成する凸部又は凹部は通例、入射面に沿う方向の長辺面と短辺面からなる斜面の繰返し単位にて周期的に形成される。なお凸部又は凹部は、それを形成する斜面の基準面との交点を結ぶ直線に基づき、斜面の交点（頂点）が当該直線よりも突出しているか（凸）、窪んでいるか（凹）に基づく。

【0060】また凸部又は凹部を形成する斜面の長辺面と短辺面は、基準面との交点と頂点を結ぶ直線に基づいて判断されるが、光の利用効率を向上させる点などよりその長辺面の出射面に対する投影面積が短辺面のその3倍以上、就中5倍以上とすることが好ましい。さらにその長辺面を凸部の場合には入射面側に、凹部の場合には入射面に対向する側端面側に位置するように配置すること、従って入射面側に凸部の場合には長辺面が、凹部の場合には短辺面が位置するように配置することが好ましい。

【0061】前記により、短辺面に直接入射する伝送光に加えて、長辺面に入射してその反射を介し短辺面に入射する伝送光もその短辺面を介した反射にて出射面に供給（出射）することができ、光利用効率の向上をはかりうる。また長辺面は、偏光光源装置とした場合に円偏光分離層で反射された再入射光を再出射させるために機能

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する部分であり、かかる点より長辺面の出射面に対する好ましい投影面積は、短辺面のその5倍以上、特に10~100倍である。

【0062】導光板のプリズム状凹凸を設ける上下面の一方又は双方の形状は、適宜に決定してよい。好ましくは上記したように傾斜面として、入射面よりもその対向側端部を薄型化したものである。その場合、傾斜面の形状は任意に決定してよく、直線面や曲面などのように適宜な面形状とすることができる。直線面でない場合、出射面よりの出射光の出射方向を均一化する点などより

は、プリズム状凹凸を設ける面の全位置で平均傾斜角度より5度以内の範囲にあることが好ましい。

【0063】設けるプリズム状凹凸の形状も、直線法の斜面で形成されている必要はなく、屈折面や湾曲面等を含む斜面にて形成されていてもよい。また凸部又は凹部は、プリズム状凹凸面の全体で凸凹やその形状等が同じである必要はなく、垂直性に優れる出射光を得る点よりは入射側から徐々にその形状や角度が変化する構造が好ましい。

【0064】プリズム状凹凸面における凸部又は凹部のピッチは、出射光がその凸部又は凹部を介し通例ストライプ状に放出されるため明暗ムラの抑制や液晶セルとのモアレの防止などの点より小さいほど好ましい。製造精度等を考慮した好ましい凸部又は凹部の周期は、500 $\mu$ m以下、就中300 $\mu$ m以下、特に5~200 $\mu$ mである。なお周期が5 $\mu$ m未満では製造精度等の点より生産効率に乏しくなり、干渉や回折による分散が増大して液晶表示装置用のバックライトに不向きとなる。

【0065】また凸部又は凹部を形成する斜面における上記した長辺面は、その出射面に対する傾斜角が0~10度、就中5度以下、特に2度以下であることが好ましい。かかる傾斜角の範囲とすることにより、当該傾斜角より大きい角度で伝送される光が長辺面に入射して反射され、その場合に当該長辺面の傾斜角に基づいて出射面に、より平行な角度で反射されて短辺面に入射し、反射されて出射面より出射する。

【0066】前記の結果、短辺面に入射する光の入射角を一定化でき、反射角のバラツキを抑制できて出射光の平行光化をはかることができる。従って、凸部又は凹部を形成する斜面における長辺面と短辺面の当該傾斜角を調節することにより、出射光に指向性をもたせることができ、それにより出射面に対して垂直方向ないしそれに近い角度で光を出射させることが可能になる。

【0067】ちなみにアクリル樹脂からなる導光板では、その屈折率(約1.5)に基づいて端面入射光の伝送される光の最大角は41.8度であり、導光板の屈折率が增大するに伴い伝送される光の最大角は小さくなる。そのため前記長辺面の傾斜角が10度を超えると、長辺面の出射面に対する投影面積の割合が減少して長辺面を介し出射方向を制御しうる伝送光の割合が低下し、

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また長辺面を経由して短辺面に入射した伝送光と、短辺面に直接入射した伝送光との反射角のバラツキが大きくなり、出射光を平行光化する制御性が低下して出射光の指向性に乏しくなる。なお当該長辺面の傾斜角が0度では、出射光の平行化に不利となるが、本発明においては許容される。

【0068】一方、凸部又は凹部を形成する斜面における上記した短辺面は、その出射面に対する傾斜角が25~50度、就中30度以上であることが好ましい。かかる傾斜角の範囲とすることにより、直接又は長辺面を介して入射する伝送光をその短辺面を介し出射面に対して垂直又はそれに近い角度に反射して、液晶表示装置等の視認性の向上に有効に作用する方向の光を効率よく出射させることができる。

【0069】導光板における入射面の形状については、特に限定はなく、適宜に決定してよい。一般には、出射面に対して垂直な面とされるが、例えば湾曲凹形などの光源の外周等に応じた形状として、入射光率の向上をはかることもできる。また、光源との間に介在する導入部を有する入射面構造などとすることもできる。その導入部は、光源などに応じて適宜な形状とすることができる。なお出射面の形状は、フラット面などが一般的であるが、必要に応じて微細なプリズム状凹凸を設けることもできるし、拡散層を設けることもできる。さらに円偏光分離層を導光板の出射面に直接設けることもできる。

【0070】導光板は、光源の波長領域に応じそれに透明性を示す適宜な材料にて形成しうる。ちなみに可視光域では、例えばポリメチルメタクリレートの如きアクリル系樹脂、ポリカーボネートやポリカーボネート・ポリスチレン共重合体の如きポリカーボネート系樹脂、エポキシ系樹脂等で代表される透明樹脂やガラスなどの如く約400~700nmの波長範囲で透明性を示すものがあげられる。

【0071】導光板は、適宜な方法で形成したものであってよい。量産性等の点より好ましい製造方法としては、例えば熱や紫外線ないし放射線等で重合処理しうる液状樹脂を、所定のプリズム状凹凸を形成しうる型に充填ないし流延して重合処理する方法や、熱可塑性樹脂を所定のプリズム状凹凸を形成しうる金型に加熱下に押付けて形状を転写する方法、加熱溶融させた熱可塑性樹脂あるいは熱や溶媒を介して流動化させた樹脂を所定の形状に成形しうる金型に充填する射出成形等の方法などがあげられる。

【0072】導光板は、例えば光の伝送を担う導光部にプリズム状凹凸面形成用のシートを接着したものの如く、異種材料の積層体などとして形成されていてもよく、1種の材料による一体的単層物として形成されている必要はない。上記した導光板では、短辺面と長辺面の面積比や傾斜角、プリズム状凹凸面の形状や曲率等の制御に基づいて出射光の角度分布や面内分布等の特性を調

節することができる。

【0073】ちなみに、屈折率が1.5でプリズム状凹凸面が曲率を有しない傾斜面であり、初期出射光が垂直に出射する導光板の場合、長辺面の出射面に対する傾斜角を6.6度以下とすることで、円偏光分離層を介した再入射光を10度以内の角度変化で再出射させることができる。またその場合、プリズム状凹凸面が曲率を有するときには当該傾斜角が6.6度以下となる部分を上記した所定面積以上の割合で有することにより、当該再入射光を10度以内の角度変化で再出射させることができる。

【0074】導光板の厚さは、使用目的による導光板のサイズや光源の大きさなどにより適宜に決定することができる。液晶表示装置等に用いる場合の導光板の一般的な厚さは、その入射面にに基づき20mm以下、就中0.1~10mm、特に0.5~8mmである。

【0075】導光板の出射面の対向面には、図例の如く必要に応じて反射層41、好ましくは金属反射層を配置することができる。かかる反射層は、当該対向面からの漏れ光の発生を防止して出射効率の向上に有効であり、偏光源装置の偏光変換手段として機能する。反射層は、当該対向面に一体化されていてもよいし、反射シート等として重ね合されていてもよく、本発明にては適宜な配置形態を採ることができる。

【0076】前記において金属からなる反射層によれば、反射時に偏光特性を効率的に反転させることができ、その偏光変換効率が屈折率相違の界面を介した全反射や拡散反射による場合よりも優れている。ちなみに金属面に概ね垂直に円偏光が入射すると、円偏光の左右の変換効率は100%近い値となり、入射角30度位までは90%以上の変換効率を示す。

【0077】偏光変換効率の点より好ましい金属反射層は、アルミニウム、銀、金、銅又はクロムなどからなる高反射率の金属の少なくとも1種を含有する金属面を有するものである。導光板の出射面の対向面との密着性に優れる金属反射層は、バインダ樹脂による金属粉末の混入塗工層や、蒸着方式等による金属薄膜の付設層などとして形成することができる。金属反射層は、多層干渉薄膜などとして形成されていてもよく、その片面又は両面には、必要に応じ反射率の向上や酸化防止等を目的とした適宜なコート層を設けることもできる。

【0078】なお反射層については、前記の反射層41に代えて、あるいはその反射層と共に、導光板の出射面の対向面に沿って反射板を設けることもできる。導光板の当該対向面に反射板を設ける方式は、長辺面の傾斜角が同一の場合、円偏光分離層を介した再入射光の再出射角を小さくできる利点がある。その反射板については、前記の反射層に準じることができ、金属反射面を有する反射板が好ましく用いられる。従って反射板としては、金属薄膜を付設した樹脂シートや金属箔、金属板などの適

宜なものを用いることができる。反射板の表面は、鏡面であることを必須とせず、小さい角度の複曲面や連続曲面などとして全体的には均一に形成されていてもよい。

【0079】また反射板としては、再出射光の広がりを抑制する点などより、平行光を入射させた場合の反射光の反射角の広がりの半値幅の半角が10度以内、就中5度以内のものが好ましい。従って反射板としては、反射率が高く、反射角の広がりが小さい適宜なものを用いる。凹凸や圧延ロール等による粗表面を有して反射光の反射角が若干広がるようにしたものであってもよい。

【0080】上記した導光板によれば、それを用いて高精度に平行化された光を視認に有利な垂直性に優れる方向に出射し、光源からの光を効率よく利用して明るさに優れる偏光源装置を得ることができ、ひいては明るくて見やすく低消費電力性に優れる液晶表示装置などの種々の装置を形成することができる。なお導光板としては、それに基づく出射光の波長域と、円偏光分離層が所定外の円偏光として反射する光の波長域が可及的に一致するものが好ましく用いられる。

【0081】サイドライト型のバックライトは、図例の如く通例、導光板の入射面に光源42を配置することにより形成される。その光源としては適宜なものを用いるが、例えば(冷、熱)陰極管等の線状光源や発光ダイオード等の点光源、あるいはその線状又は面状等のアレイ体などが好ましく用いられる。当該バックライトの形成に際しては、必要に応じて図例の如く、線状光源からの発散光を導光板の側面に導くために光源を包囲する光源ホルダ43や、光の出射方向制御用のプリズムシートなどの適宜な補助手段を配置した組合せ体とすることもできる。

【0082】なお光源ホルダとしては、高反射率金属薄膜を付設した樹脂シートや金属箔などが一般に用いられる。光源ホルダを導光板の端部に接着剤等を介して接着する場合には、その接着部分についてはプリズム状凹凸の形成を省略することもできる。また、光源ホルダを導光板の所定面に延設して反射板を兼ねさせることもできる。

【0083】偏光源装置の形成に好ましく用いられる導光板は、側面よりの入射光を高い効率で出射面より出射させ、その出射光が高い指向性、就中、出射面に対する垂直性に優れる指向性を示すと共に、円偏光分離層を介した再入射光の再出射効率に優れ、その再出射光の指向性と出射角度が初期出射光の指向性と出射角度に可及的に一致し、かつ円偏光分離層を介した再入射光を少ない反射繰返し数で、就中、反射の繰返しなく出射するようにしたものである。

【0084】上記のように本発明による偏光源装置は、円偏光分離層による反射光(再入射光)を偏光変換による出射光として再利用することで反射ロス等を防止し、その出射光を必要に応じ位相差層等を介し直線偏光

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成分をリッチに含む光状態に変換して偏光板を透過しやすくし吸収ロスを防止して、光利用効率の向上をはかりうるようにしたものである。この方式により、理想的には偏光板を透過する光量を約2倍に増量しうるが、光源として利用する点よりは、偏光板を透過しうる直線偏光成分を65%以上、就中70%以上含むことが好ましい。

【0085】本発明による偏光光源装置は、上記の如く光の利用効率に優れて明るく、垂直性に優れて明暗ムラの少ない光を提供し、大面積化等も容易であることより

10 液晶表示装置等におけるバックライトシステムなどとして種々の装置に好ましく用いることができる。  
【0086】図5に本発明による偏光光源装置5をバックライトシステムに用いた液晶表示装置6を例示した。61が下側の偏光板、62が液晶セル、63が上側の偏光板、64が補償用拡散板である。下側の偏光板61や補償用拡散板64は、必要に応じて設けられる。

【0087】液晶表示装置は一般に、液晶シャットとして機能する液晶セルとそれに付随の駆動装置、偏光板、バックライト、及び必要に応じての補償用位相差板等の構成部品を適宜に組立てることなどにより形成される。本発明においては、上記した偏光光源装置を用いる点を除いて特に限定はなく、従来に準じて形成することができる。特に、直視型の液晶表示装置を好ましく形成することができる。

【0088】従って用いる液晶セルについては特に限定はなく、適宜なものをを用いる。就中、偏光状態の光を液晶セルに入射させて表示を行うものに有利に用いられ、例えばツイストネマチック液晶やスーパーツイストネマチック液晶を用いた液晶セル等に好ましく用いるが、非ツイスト系の液晶や二色性染料を液晶中に分散させたゲストホスト系の液晶、あるいは強誘電性液晶を用いた液晶セルなどにも用いる。液晶の駆動方式についても特に限定はない。

【0089】なお高度な直線偏光の入射による良好なコントラスト比の表示を得る点よりは偏光板として、特にバックライト側の偏光板として、例えばヨウ素系や染料系の吸収型直線偏光子などの如く偏光度の高いものを用いた液晶表示装置が好ましい。液晶表示装置の形成に際しては、例えば視認側の偏光板の上に設ける拡散板やアンチグレア層、反射防止膜や保護層や保護板、あるいは液晶セルと偏光板の間に設ける補償用位相差板などの適宜な光学層を適宜に配置することができる。

【0090】前記の補償用位相差板は、複屈折の波長依存性などを補償して視認性の向上等をはかることを目的とするものである。本発明においては、視認側又は／及びバックライト側の偏光板と液晶セルの間等に必要に応じて配置される。なお補償用位相差板としては、波長域などに応じて適宜なものをを用いることができ、1層又は2層以上の重畳層として形成されていてよい。補償用位

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相差板は、上記した直線偏光変換用の位相差板で例示の延伸フィルムなどとして得ることができる。

【0091】本発明において、上記した偏光光源装置や液晶表示装置を形成する光学素子ないし部品は、全体的又は部分的に積層一体化されて固着されていてもよいし、分離容易な状態に配置したものであってもよい。液晶表示装置等の形成に際しては、垂直性や平行光性に優れる出射光を供給し、円偏光分離層を介した再入射光も散乱等によるロスや角度変化の少ない状態で、かつ初期出射光との方向の一致性よく再出射して、視認性の向上に有効な方向の出射光を効率よく供給する偏光光源装置が好ましく用いうる。

【0092】

【実施例】

参考例1

アクリル系の主鎖を有するガラス転移温度が57℃の側鎖型コレステリック液晶ポリマーを、厚さ10μmのトリアセチルセルロースフィルムのポリイミドラビング処理面にスピンコート方式で成膜後(厚さ3μm)、140℃で30秒間加熱後さらに120℃で2分間加熱して急冷し、鏡面状の選択反射状態を呈する青系の円偏光分離板を得た。これは、選択反射の中心波長が450nmで、左円偏光を透過するものであった。

【0093】参考例2

アクリル系の主鎖を有するガラス転移温度が64℃の側鎖型コレステリック液晶ポリマーを、厚さ10μmのトリアセチルセルロースフィルムのポリイミドラビング処理面にスピンコート方式で成膜後(厚さ3μm)、150℃で30秒間加熱後さらに130℃で2分間加熱して急冷し、鏡面状の選択反射状態を呈する緑系の円偏光分離板を得た。これは、選択反射の中心波長が550nmで、左円偏光を透過するものであった。

【0094】参考例3

アクリル系の主鎖を有するガラス転移温度が75℃の側鎖型コレステリック液晶ポリマーを、厚さ10μmのトリアセチルセルロースフィルムのポリイミドラビング処理面にスピンコート方式で成膜後(厚さ3μm)、170℃で30秒間加熱後さらに145℃で2分間加熱して急冷し、鏡面状の選択反射状態を呈する赤系の円偏光分離板を得た。これは、選択反射の中心波長が650nmで、左円偏光を透過するものであった。

【0095】実施例1

参考例1、参考例2及び参考例3で得た円偏光分離板を、青系、緑系、赤系の順序で接着積層して重畳型の円偏光分離板を得、その赤系円偏光分離板の上に広帯域1/4波長板を介して偏光板を左円偏光板となるように配置して光学素子を得た。

【0096】比較例1

1/4波長板と偏光板を、青系の円偏光分離板側に配置したほかは実施例1に準じて光学素子を得た。

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## 【0097】比較例2

円偏光分離板の配置順序を赤系、青系、緑系とし、その緑系側に1/4波長板と偏光板を配置したほかは実施例1に準じて光学素子を得た。

## 【0098】比較例3

円偏光分離板の配置順序を緑系、赤系、青系とし、その青系側に1/4波長板と偏光板を配置したほかは実施例1に準じて光学素子を得た。

## 【0099】比較例4

円偏光分離板の配置順序を緑系、青系、赤系とし、その赤系側に1/4波長板と偏光板を配置したほかは実施例1に準じて光学素子を得た。

## \*【0100】比較例5

円偏光分離板の配置順序を青系、赤系、緑系とし、その緑系側に1/4波長板と偏光板を配置したほかは実施例1に準じて光学素子を得た。

## 【0101】評価試験

実施例、比較例で得た光学素子とその偏光板側を上側にして、均一な明るさの面光源上に配置し、視角の変化による色度変化を測定して、5点法で評価した。5点が最も視角依存性の少ないこと、従って視角による色変化の小さいことを意味する。

【0102】前記の結果を次表に示した。

実施例1	比較例1	比較例2	比較例3	比較例4	比較例5
5	3	1	2	1	4

## 【図面の簡単な説明】

【図1】円偏光分離層例の断面図

【図2】光学素子例の断面図

【図3】他の光学素子例の断面図

【図4】偏光光源装置例の断面図

【図5】液晶表示装置例の断面図

【符号の説明】

※1：円偏光分離層

11, 13, 15：コレステリック液晶層

20 12, 14, 16：支持基材

2：位相差層 3：偏光板

5：偏光光源装置

4：導光板 41：反射層 42：光源

※ 6：液晶表示装置

【図1】



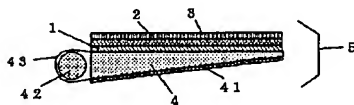
【図2】



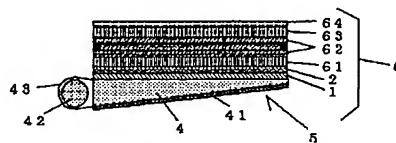
【図3】



【図4】



【図5】



## PATENT ABSTRACTS OF JAPAN

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(54) SEPARATION LAYER FOR CIRCULAR POLARIZED LIGHT, OPTICAL ELEMENT, POLARIZATION LIGHT SOURCE DEVICE AND LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain a separation layer for circular polarized light which shows little change in colors by changes in the visual angle for outgoing light and to improve the use efficiency to emit light which enters through the side face by laminating plural cholesteric liquid crystal layers having different reflection wavelengths according to the order of the center wavelengths for reflected light.

SOLUTION: This separation layer 1 for circular polarized light consists of cholesteric liquid crystal layers 11, 13, 15 and supporting members 12, 14, 16. In this method, the separation layer 1 for circular polarized light is produced by laminating plural cholesteric liquid crystal layers 11, 13, 15 having different reflection wavelengths in the order of center wavelengths of reflected light to form a two-layer or more structure. These cholesteric liquid crystal layers 11, 13, 15 are laminated so as to obtain a wider wavelength range for the separation function. As for the cholesteric liquid crystal layers 11, 13, 15, a proper material which separates natural light into right-hand and left-hand circular polarized light as transmitted light and reflected light by a Granjean orientation can be used.





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CLAIMS

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[Claim(s)]

[Claim 1] The circular polarization of light detached core characterized by superimposing two or more cholesteric-liquid-crystal layers from which reflected wave length differs based on the main wavelength of the reflected light as the sequence of merits and demerits.

[Claim 2] The circular polarization of light detached core on which reflected wave length superimposes a blue system, a green system, or three sorts of reddish cholesteric-liquid-crystal layers in claim 1 in the combination from which 30-200nm of main wavelength of the reflected light is different.

[Claim 3] The circular polarization of light detached core whose total thickness in which the cholesteric-liquid-crystal layer is attached on the support base material, and the total thickness of each cholesteric-liquid-crystal layer contains a support base material by 2-50 micrometers in claim 1 or 2 is 20-200 micrometers.

[Claim 4] The optical element which has both a phase contrast layer, or both [ one side or ] in the cholesteric-liquid-crystal layer side of the longest wavelength in a circular polarization of light detached core according to claim 1 to 3.

[Claim 5] The optical element to which a phase contrast layer is located between a circular polarization of light detached core and a polarizing plate in claim 4.

[Claim 6] Polarization light equipment characterized by having a circular polarization of light detached core according to claim 1 to 3, claim 4, or an optical element given in 5 in the outgoing radiation side side of the light guide plate which carries out outgoing radiation of the incident light from a side face from one side of a vertical side.

[Claim 7] The liquid crystal display characterized by having arranged polarization light equipment according to claim 6 in one side of a liquid crystal cell.

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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention is excellent in brightness at the circular polarization of light detached core which prevented the color change by the viewing angle of a cholesteric-liquid-crystal layer and the polarization light equipment which is excellent in the efficiency for light utilization using it, and a list, and relates to the liquid crystal display of right visibility.

[0002]

[Background of the Invention] The lighting system which prepares a reflecting layer in the inferior surface of tongue of the light guide plate of the side light mold which was made to carry out outgoing radiation from one side of the upper and lower sides of the incident light from a side face, prepares the circular polarization of light detached core which consists of a cholesteric-liquid-crystal layer in an outgoing-radiation side, separates into the transmitted light and the reflected light which consist of the circular polarization of light of right and left of incident light through the circular polarization of light detached core, is made to reflect the reflected light through a reflecting layer at the bottom conventionally, and was made to carry out re-outgoing radiation from an outgoing-radiation side was proposed (JP,3-45906,A, JP,6-324333,A, JP,7-36032,A).

[0003] Since it is deficient in the light which about 55% of light guide plate outgoing radiation light is absorbed, and can be used effectively in case it penetrates a polarizing plate with the usually light of unpolarized light, this lighting system is carried out as [ supply / by considering light as polarization / a polarizing plate ], prevents absorption by the polarizing plate and aims at this aiming at improvement in efficiency for light utilization, and raising the brightness of a liquid crystal display etc. The wavelength ( $\lambda$ ) of the reflected light through the aforementioned circular polarization of light detached core is expressed with formula:  $\lambda = \frac{p}{\cos \theta}$  based on Tsunemitsu, the rate of abnormality optical refraction ( $n_o$ ,  $n_e$ ), and spiral pitch ( $p$ ) by the birefringence of a cholesteric-liquid-crystal layer, when an incident angle is set to  $\theta$ .

[0004] Since above  $n_o$  and  $n_e$  are not large values, usually, the wavelength field of the reflected light is narrower than a light field, and the transmitted light and the reflected light through the cholesteric-liquid-crystal layer of a monolayer can color and be seen, and are called selective reflection nature and circular dichroism. Although the attempt which changes the pitch of a cholesteric-liquid-crystal layer in the thickness direction, and extends the wavelength field of the reflected light also occurs (JP,6-281814,A), the approach of neutral-colors-izing said coloring is taken as a circular polarization of light detached core which superimposed two or more cholesteric-liquid-crystal layers from which the wavelength field of the reflected light generally differs (JP,1-133003,A).

[0005] However, when changing a viewing angle, and outgoing radiation light blue-ized and changed the viewing angle further, there was a trouble of color change of carrying out reddening in the circular polarization of light detached core of the above mentioned superposition mold. Although there is also a proposal which a foreground color shifts to a blue side, therefore sets up the bright-line-spectrum wavelength of an emitter in the core and the middle of a short wavelength edge of the reflected wave length by the circular polarization of light detached core when it applies to a liquid crystal display by using a circular polarization of light detached core

as a back light system (JP,7-36025,A), the solution of the color change by the aforementioned viewing-angle change does not become.

[0006]

[The technical technical problem of invention] This invention makes it a technical problem to obtain a circular polarization of light detached core with little color change by viewing-angle change of the outgoing radiation light at the time of superimposing two or more cholesteric-liquid-crystal layers, and to obtain the polarization light equipment which is excellent in the efficiency for light utilization which carries out outgoing radiation of the incident light from a side face efficiently, and the liquid crystal display which is bright and is excellent in visibility.

[0007]

[Means for Solving the Problem] The outgoing radiation side side of the circular polarization of light detached core characterized by this invention superimposing two or more cholesteric-liquid-crystal layers from which reflected wave length differs based on the main wavelength of the reflected light as the sequence of merits and demerits, and the light guide plate which carries out outgoing radiation of the incident light from a side face from one side of a vertical side is provided with the polarization light equipment characterized by having the circular polarization of light detached core concerned.

[0008]

[Effect of the Invention] By the above-mentioned configuration which superimposed two or more cholesteric-liquid-crystal layers as the sequence of the merits and demerits of reflected wave length, a circular polarization of light detached core with a small color change of the outgoing radiation light by viewing-angle change can be obtained, and the polarization light equipment which is excellent in efficiency for light utilization using it, as a result the liquid crystal display which is bright and is excellent in visibility can be obtained. Although the reason outgoing radiation light carries out color change by viewing-angle change may be for penetrating a circular polarization of light detached core as polarization, the reason the color change by viewing-angle change is controlled by the aforementioned superposition method not certain therefore is unknown.

[0009]

[Embodiment of the Invention] The circular polarization of light detached core of this invention superimposes two or more cholesteric-liquid-crystal layers from which reflected wave length differs based on the main wavelength of the reflected light as the sequence of merits and demerits. The example was shown in drawing 1. 1 is a circular polarization of light detached core, and a cholesteric-liquid-crystal layer, and 12, 14 and 16 are [ 11, 13, and 15 ] support base materials.

[0010] As a cholesteric-liquid-crystal layer, the proper thing which divides the natural light into the circular polarization of light on either side as the transmitted light and the reflected light by GURANJAN orientation can be used. Incidentally as the example, the sheet which has the layer which has a cholesteric-liquid-crystal phase, and the layer which consists of a liquid crystal polymer which presents a cholesteric phase above all, the sheet which developed the layer concerned on the glass plate etc., or the film which consists of a liquid crystal polymer which presents a cholesteric phase is raised.

[0011] As for a cholesteric-liquid-crystal layer, in the above, it is desirable to carry out orientation to homogeneity as much as possible. The cholesteric-liquid-crystal layer of homogeneity orientation offers the reflected light without dispersion, is advantageous to expansion of the angle of visibility of a liquid crystal display etc., and suitable for formation of

the direct viewing type liquid crystal display by which direct observation is especially carried out also from across.

[0012] The circular polarization of light detached core by this invention can form two or more cholesteric-liquid-crystal layers from which reflected wave length differs by superimposing two-layer or three layers or more as the sequence of merits and demerits based on the main wavelength of the reflected light. Superposition-ization of this cholesteric-liquid-crystal layer is aimed at extensive wavelength region-ization of isolation.

[0013] Namely, although a limitation is located in the wavelength region which shows selective-reflection nature (circular dichroism) and the limitation also has usually the case of the large range which reaches about 100nm wavelength region in the cholesteric-liquid-crystal layer of a monolayer, since it is less than the whole region of the light desired when applying to a liquid crystal display etc. also in the wavelength range, it aims at making the wavelength region which is made to superimpose the cholesteric-liquid-crystal layer from which selective-reflection nature (reflected wave length) differs, and shows circular dichroism expand in such a case.

[0014] It is the combination which reflects the circular polarization of light of the same direction, and the cholesteric-liquid-crystal layer which is incidentally in the range whose main wavelength of selective reflection is 300-900nm can be used in the combination from which the main wavelength of selective reflection differs, and combination which is different 30-200nm above all, respectively, and the circular polarization of light detached core which can cover the wavelength region where a light region etc. is large by superimposing the 2-6 kinds can be formed efficiently. Especially as an object for the lights, that on which reflected wave length superimposed three sorts of cholesteric-liquid-crystal layers, a blue network, a green network, and a red network, is more desirable than points, such as thin-shape-izing by the small number of superposition.

[0015] It aims at increase in quantity of the polarization in the condition that it can prevent and use that the point used as a superposition object in the combination of what reflect the circular polarization of light of the same above mentioned polarization direction will be in a polarization condition which arranges the phase condition of the circular polarization of light reflected on each class, and is different in each wavelength region.

[0016] A proper thing may be used for the cholesteric liquid crystal which forms a circular polarization of light detached core, and there is especially no limitation in it. Therefore, various things, such as a principal chain mold with which the straight-line-like atomic group (meso gene) of the conjugate property which gives a liquid crystal stacking tendency was introduced into the principal chain and side chain of a polymer, and a side-chain mold, can be used. The wavelength region of selective reflection becomes large and the larger cholesteric-liquid-crystal molecule of phase contrast can be used more preferably than points, such as allowances over mitigation of a number of layers, or the wavelength shift at the time of a large angle of visibility. Moreover, rather than weight or the point of \*\*\*\*\*, a liquid crystal polymer can use preferably. Furthermore, as the liquid crystal polymer, that whose glass transition temperature is 30-150 degrees C can use preferably from points, such as handling nature and the stability of the orientation in operating temperature.

[0017] Incidentally, as an example of the liquid crystal polymer of the above mentioned principal chain mold, it has the structure which combined the meso gene radical which minds the spacer section which gives flexibility if needed, and consists of a Para permutation ring compound etc., for example, polymers, such as a polyester system, a polyamide system, a polycarbonate system, and a polyester imide system, are raised.

[0018] Moreover, a thing, a nematic system liquid crystal polymer of low-molecular chiral agent content, a liquid crystal polymer of chiral component installation, a mixed liquid crystal polymer of a nematic system and a cholesteric system, etc. which have the low-molecular-liquid-crystal compound (meso gene section) which makes polyacrylate, polymethacrylate, a polysiloxane, poly malonate, etc. a principal chain frame, minds the spacer section which consists of an atomic group of conjugate property as a side chain as an example of the liquid crystal polymer of a side-chain mold if needed, and consists of a Para permutation ring compound etc. are raised.

[0019] Like the above, it can consider as the thing of a cholesteric stacking tendency with the method which introduces the proper chiral component which consists of a compound which has asymmetrical carbon also in what has the Para permutation ring compound which gives the nematic stacking tendency which consists of the Para permutation aromatic-series unit, the Para permutation cyclohexyl ring unit, etc. like for example, an azomethine form, an azo form, an AZOKISHI form and an ester form, a biphenyl form and a phenylcyclohexane form, and a bicyclo hexane form, a low-molecular chiral agent, etc. (JP,55-21479,A, U.S. Pat. No. 5332522, etc.). In addition, a cyano group, the alkyl group, alkoxy group of the end substituent in the para position in the Para permutation ring compound, etc. may be proper.

[0020] Moreover, as the spacer section, for example, polymethylene chain-(CH<sub>2</sub>) n-, polyoxymethylene chain-(CH<sub>2</sub>CH<sub>2</sub>O) m-, etc. which show flexibility are raised. the chemical structure of the meso gene section etc. determines suitably the number of cycles of the structural unit which forms the spacer section -- having -- general -- the case of a polymethylene chain -- n -- 0-20, and the case where they are 2-12, and a polyoxymethylene chain above all -- m -- 0-10 -- it is 1-3 above all.

[0021] In addition, the proper method according to the usual polymer composition to which copolymerization for example, of the component monomer is carried out with a radical polymerization method, a cationic polymerization method, an anionic polymerization method, etc. can perform preparation of the above-mentioned principal chain mold liquid crystal polymer. Moreover, the monomer addition polymerization method which polymer-izes the monomer to which preparation of a side-chain mold liquid crystal polymer also introduced the meso gene radical into the monomer for vinyl system principal chain formation like the ester of an acrylic acid or a methacrylic acid through the spacer radical if needed by a radical polymerization method etc., The method which carries out the addition reaction of the vinyl permutation meso gene monomer to the bottom of existence of a platinum system catalyst through Si-H association of polyoxy methyl silylene, The method which introduces a meso gene radical by the esterification reaction using a correlation migration catalyst through the functional group given to the principal chain polymer, A method with the proper method which carries out a polycondensation reaction can perform the monomer which introduced the meso gene radical into some malonic acids through the spacer radical if needed, and diol.

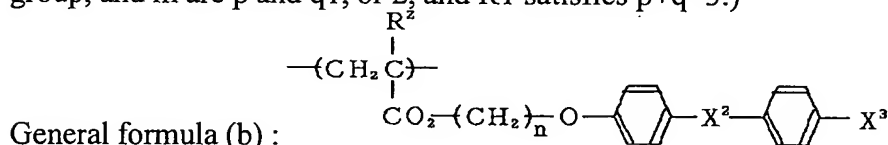
[0022] In the above Membrane formation nature and the good GURANJAN stacking tendency of a mono-domain condition, The short-time nature of orientation processing, the stable stability to a vitreous state, the controllability of the spiral pitch of a cholesteric phase, The liquid crystal polymer which can be used more preferably than points, such as the plasticity of the circular polarization of light detached core which orientation conditions, such as a pitch, cannot change easily due to operating temperature, and is lightly [ it is thin and ] excellent in endurance or preservation stability the copolymer which uses as a component the monomeric unit expressed with the following general formula (a), and the monomeric unit expressed with a general formula (b) -- above all with 60 - 95 % of the weight of monomeric units of a general formula (a) Let the

copolymer which consists of 40 - 5 % of the weight of monomeric units of a general formula (b) be a component (Japanese Patent Application No. No. 251818 [ seven to ]).

[0023] general formula (a): -- < -- IMG solvent refined

coal="/NSAPITMP2/web738/IMAGE/20060712231900024350.gif" -- WIDTH= --  
"336"HEIGHT="76"ALT=" ID=000003" -- >

(However, the integer of 1-6 and X1 are two COs or an OCO radical, and hydrogen or a methyl group, and m are p and q1, or 2, and R1 satisfies p+q=3.)



R2 [ however, ] -- hydrogen or a methyl group, and n -- the integer of 1-6, and X2 -- two COs or an OCO radical, and X3 -CO-R3 or -R4 -- it is -- the R3

R4

It comes out, and it is and R5 is as follows.

[0024] The acrylic monomer which can form the monomeric unit expressed with the aforementioned general formula (a) and a general formula (b) is compoundable by the proper approach. As the example, first ethylene chlorohydrin and 4-hydroxybenzoic acid After carrying out heating reflux in an alkali water solution by making potassium iodide into a catalyst and obtaining hydroxycarboxylic acid, Carry out dehydration of it to an acrylic acid or a methacrylic acid, and it considers as acrylate (meta). By esterifying the (meta) acrylate under existence of DCC (dicyclohexylcarbodiimide) and DMAP (dimethylamino pyridine) by the 4-cyano-4'-hydroxy biphenyl, the method of obtaining the monomer belonging to a general formula (a) raises, and it is \*\*\*\*.

[0025] moreover, as a synthetic example of the acrylic monomer belonging to a general formula (b) After carrying out the heating reflux of hydroxyalkyl halide and the 4-hydroxybenzoic acid in an alkali water solution by making potassium iodide into a catalyst first and obtaining hydroxycarboxylic acid, Dehydration of it is carried out to an acrylic acid or a methacrylic acid. As acrylate (meta) the acrylate (meta) of *Perilla frutescens* (L.) Britton var. *crispa* (Thunb.) Decne. The approach of esterifying under existence of DCC and DMAP, the approach of esterifying the (meta) acrylate under existence of DCC and DMAP after the aforementioned dehydration with the phenol which has an asymmetrical carbon radical in the 4th place, etc. are raised with the phenol which has CO radical of R three-set content in the 4th place.

[0026] Therefore, other monomers belonging to an aforementioned general formula (a) and an

aforementioned general formula (b) are compoundable according to the above using the proper raw material which has the introductory target radical. In addition, the phenol which has CO radical of R three-set content in the 4th aforementioned place For example, make methyl chloroformate and 4-hydroxybenzoic acid react in an alkali water solution first, and it considers as a carboxylic acid. After making it into acid chloride by oxalyl chloride, by the approach of making it reacting with H-R3 in a pyridine/tetrahydrofuran, introducing R3 set, processing it with aqueous ammonia subsequently, and removing a protective group etc. Moreover, the phenol which has an asymmetrical carbon radical in the 4th place can be obtained by the approach of carrying out azeotropy dehydration of for example, a 4-hydroxy benzaldehyde and the (S)-(-)-1-phenyl ethylamine in toluene etc.

[0027] The above-mentioned copolymer can change the spiral pitch of cholesteric liquid crystal by changing the content of the monomeric unit expressed with the general formula (b).

Therefore, the wavelength which shows circular dichroism by control of the content of the monomeric unit expressed with a general formula (b) can be adjusted, and the optical element which shows circular dichroism to the light of a light region can also be obtained easily.

[0028] Formation of the cholesteric-liquid-crystal layer by the liquid crystal polymer can be performed by the approach according to the conventional orientation processing. Incidentally as the example, on a support base material, polyimide and polyvinyl alcohol, The orientation film which formed film, such as polyester, polyarylate and polyamidoimide, and polyether imide, and carried out rubbing processing with the rayon cloth etc., A liquid crystal polymer is developed on the proper orientation film which consists of a method vacuum evaporation layer of slanting of SiO<sub>2</sub>, or orientation film by extension processing. Or more than glass transition temperature It heats under to isotropic phase transition temperature, after the liquid crystal polymer molecule has carried out GURANJAN orientation, it cools under to glass transition temperature, and it considers as a vitreous state, and the approach of forming the flozen layer by which the orientation concerned was fixed etc. is raised.

[0029] As the aforementioned support base material, proper things, such as a monolayer which consists of plastics like triacetyl cellulose, polyvinyl alcohol and polyimide, polyarylate and polyester, a polycarbonate, polysulfone and polyether sulphone, amorphous polyolefine and a denaturation acrylic polymer, and epoxy system resin, for example, a laminated film, or a glass plate, can be used. Plastic film is more desirable than points, such as thin-shape-izing, and a small thing has the phase contrast as much as possible more desirable than points, such as improvement in the use effectiveness of the light by prevention of change of a polarization condition, by the birefringence.

[0030] Expansion of a liquid crystal polymer can carry out thin layer expansion of the solution by the solvent of a liquid crystal polymer by proper approaches, such as a spin coat method, the roll coat method, the flow coat method and the printing method, a dip coating method and the flow casting forming-membranes method, the bar coat method, and gravure, and can be performed by the approach of carrying out desiccation processing of it if needed etc. As the aforementioned solvent, proper things, such as a methylene chloride, a cyclohexanone and a trichloroethylene, tetrachloroethane and N-methyl pyrrolidone, and a tetrahydrofuran, can be used, for example.

[0031] Moreover, the heating melt of a liquid crystal polymer and the heating melt in the condition of presenting an isotropic phase preferably can be developed according to the above, and the approach which does not use solvents, such as an approach which develops to a thin layer and it is made to solidify further, maintaining the melting temperature if needed, therefore

the health nature of work environment, etc. can develop a liquid crystal polymer also by the good approach. In addition, on the occasion of expansion of a liquid crystal polymer, the superposition method of the cholesteric-liquid-crystal layer which minded the orientation film if needed for the purpose of thin-shape-izing etc. can be taken.

[0032] Heat-treatment for carrying out orientation of the expansion layer of a liquid crystal polymer can be performed by heating to the temperature requirement from the glass transition temperature of a liquid crystal polymer to isotropic phase transition temperature, i.e., the temperature requirement where a liquid crystal polymer presents a liquid crystal phase, as described above. Moreover, immobilization of an orientation condition can be performed by cooling under to glass transition temperature, and there is especially no limitation about the cooling condition. Usually, since the aforementioned heat-treatment can be performed at the temperature of 300 degrees C or less, generally a natural-air-cooling method is taken.

[0033] The flozen layer of the liquid crystal polymer formed on the support base material can be used for a circular polarization of light detached core as it is as an one object with a support base material, and can also be used as a circular polarization of light detached core which exfoliates from Japanese lacquer and a support base material, and consists of a film etc. When forming as an one object with the support base material which consists of a film etc., it is more desirable than points, such as the tightness of the change of state of polarization, that phase contrast uses a small support base material as much as possible.

[0034] Especially the thickness of a cholesteric-liquid-crystal layer has 2-10 micrometers more desirable than points, such as a size of turbulence of orientation, prevention of a permeability fall, and the wavelength range of selective reflection, 1-30 micrometers above all 0.5-50 micrometers. Moreover, it is more desirable than points, such as thin-shape-izing of a circular polarization of light detached core, that 2-50 micrometers of 3-30 micrometers of total thickness of each cholesteric-liquid-crystal layer are 5-10 micrometers especially above all. When it furthermore has a support base material, it is desirable that 20-200 micrometers of 25-150 micrometers of total thickness including the base material are 30-100 micrometers especially above all. On the occasion of formation of a circular polarization of light detached core, the various additives which become a cholesteric-liquid-crystal layer from a stabilizer, a plasticizer, or metals can be blended if needed.

[0035] The circular polarization of light detached core used in this invention can be made into a gestalt with proper cel gestalt which pinched the cholesteric-liquid-crystal layer which consists for example, of a low-molecular-weight object with transparence base materials, such as glass and a film, gestalt which supported the cholesteric-liquid-crystal layer which consists of a liquid crystal polymer with the transparence base material, gestalt which consists of a film of the liquid crystal polymer of a cholesteric-liquid-crystal layer, gestalt which superimposed those gestalt objects in proper combination.

[0036] In the aforementioned case, a cholesteric-liquid-crystal layer can also be held according to the reinforcement, operability, etc. with the support base material more than one layer or two-layer. the point of preventing the change of state of polarization in using the support base material more than two-layer etc. -- for example, the film of non-orientation -- even if it carries out orientation, a small thing can use [ phase contrast ] preferably as much as possible like the small triacetate film of a birefringence etc. Gestalten more desirable than points, such as thin-shape-izing, are the gestalt supported with the transparence base material, a gestalt which consists of a film of a liquid crystal polymer.

[0037] In addition, as for each class of superposition, being formed as a flat layer is more



desirable than the point that a circular polarization of light detached core copes with equalization of the above-mentioned separability ability, and the wavelength shift of oblique-incidence light etc. Use of a liquid crystal polymer is more advantageous to especially superposition of a cholesteric-liquid-crystal layer than points, such as manufacture effectiveness and thin-film-izing. Superposition processing can take proper methods, such as every mere pile and adhesion through adhesives, such as a binder.

[0038] In this invention, one sort of proper optical layers, such as a phase contrast layer, a polarizing plate, and a diffusion layer, or two sorts or more can be arranged, and various optical elements can be formed in the cholesteric-liquid-crystal layer side of the longest wavelength which becomes the optical outgoing radiation side of a circular polarization of light detached core. The example was shown in drawing 2 and drawing 3. 2 is a phase contrast layer and 3 is a polarizing plate.

[0039] A phase contrast layer functions as a linearly polarized light conversion means, the circular polarization of light which carried out outgoing radiation from the circular polarization of light detached core carries out incidence to a phase contrast layer, a phase change is received, the light of the wavelength on which the phase change is equivalent to quarter-wave length is changed into the linearly polarized light, and other wavelength light is changed into elliptically polarized light. The changed elliptically polarized light turns into such flat elliptically polarized light that it is close to the wavelength of the light changed into the aforementioned linearly polarized light. Outgoing radiation of the light in the condition that many linearly polarized light components which may penetrate a polarizing plate are included will be carried out as a result of [ this ] a phase contrast layer.

[0040] By changing into a condition with many linearly polarized light components, it can consider as the light which is easy to penetrate a polarizing plate. In the case of a liquid crystal display, this polarizing plate functions as the optical layer which prevents the fall of the polarization property generated in change of the angle of visibility to a liquid crystal cell, and maintains display grace, an optical layer which realizes more advanced degree of polarization and attains better display grace.

[0041] That is, in the above, although it is possible to carry out incidence of the outgoing radiation polarization [ detached core / circular polarization of light ] to a liquid crystal cell as it is, and to attain a display, without using a polarizing plate, since improvement in the display grace described above by minding a polarizing plate etc. can be aimed at, a polarizing plate may be used if needed. In that case, it is so more advantageous that the permeability to a polarizing plate is high than the point of the brightness of a display, and since the permeability becomes so high that many linearly polarized light components of the polarization direction which is in agreement with the polarization shaft (transparency shaft) of a polarizing plate are included, outgoing radiation polarization [ detached core / circular polarization of light ] is changed into the predetermined linearly polarized light through a linearly polarized light conversion means for the purpose of it.

[0042] The liquid crystal display which can obtain the permeability which exceeds 80% when a polarization shaft is made in agreement and incidence of the linearly polarized light is carried out, therefore whose use effectiveness of light improves sharply, and is incidentally excellent in brightness although the permeability is about 43% when incidence of the natural light or the circular polarization of light is carried out to a usual iodine system polarizing plate becomes possible. Moreover, in this polarizing plate, the degree of polarization which reaches to 99.99% can also be attained. If independent, this achievement of high degree of polarization is difficult,

and the degree of polarization especially to the incident light from slant which is a circular polarization of light detached core tends to fall.

[0043] While it is equivalent to the phase contrast of quarter-wave length in the circular polarization of light which carried out outgoing radiation and being able to form many linearly polarized lights from a circular polarization of light detached core as a phase contrast layer, what can change the light of other wavelength into the flat elliptically polarized light near the linearly polarized light as much as possible [ have the major-axis direction in the parallel direction as much as possible with said linearly polarized light, and ] is desirable. A phase contrast layer can also be prepared [ polarizing plate ] in one with a circular polarization of light detached core.

[0044] By using the phase contrast layer like the above, it can arrange so that the direction of the linearly polarized light of the outgoing radiation light and the major-axis direction of elliptically polarized light may become parallel as much as possible with the transparency shaft of a polarizing plate, and the light of a condition with many linearly polarized light components which may penetrate a polarizing plate can be obtained. A phase contrast layer can be formed with the proper quality of the material, what gives transparent and uniform phase contrast is desirable, and, generally a phase contrast plate is used.

[0045] The phase contrast given in a phase contrast layer can be suitably determined according to the wavelength region of the circular polarization of light by which outgoing radiation is carried out etc. from a circular polarization of light detached core. Incidentally, from points, such as wavelength range and conversion efficiency, it also considers that it is that almost all the phase contrast plate indicates the wavelength dispersion of a forward birefringence to be from the quality-of-the-material property, and a thing with the small phase contrast and the thing which gives phase contrast 110-150nm or less especially can use 100-180nm preferably above all in a light region.

[0046] A phase contrast plate can be formed as one layer or two or more superposition layers. In the case of the phase contrast plate which consists of one layer, a smaller thing can achieve equalization of the polarization condition for every wavelength, and its wavelength dispersion of a birefringence is desirable. On the other hand, superposition-izing of a phase contrast plate is effective in amelioration of the wavelength property in a wavelength region, and the combination may be suitably determined according to a wavelength region etc.

[0047] In addition, when targetting a light region to the phase contrast plate more than two-layer, it is more desirable than the point of obtaining the light in which the layer which gives 100-180nm phase contrast is included [ of a linearly polarized light component ] as odd one or more-layer layers in many cases, like the above. Although it is more desirable than points, such as amelioration of a wavelength property, to form in the layer which gives 200-400nm phase contrast usually as for layers other than the layer which gives 100-180nm phase contrast, they are not limited to this.

[0048] A phase contrast plate can be obtained as a form birefringence sheet which comes to carry out extension processing of the film which consists of a polycarbonate, polysulfone and polyester, polymethylmethacrylate and a polyamide, poly vinyl alcohol, etc. It is so desirable that the error of the phase contrast within the field of a phase contrast layer is small, and it is more desirable than the point of maintaining luminescence reinforcement and the luminescent color to homogeneity with a large angle of visibility that the error is  $\pm 10\text{nm}$  or less above all.

[0049] The direction of the phase contrast set as a phase contrast layer or an optical axis can be suitably determined according to the oscillating direction of the linearly polarized light made into the purpose etc. In the case of the phase contrast layer which incidentally gives 135nm phase

contrast, according to the sense of the circular polarization of light, the linearly polarized light (wavelength of 540nm) whose oscillating direction is +45 degrees or -45 degrees is acquired to an optical axis. In addition, when the layer which gives 100-180nm phase contrast for the exterior side surface layer especially when a phase contrast layer consists of more than two-layer occupies, it is desirable to set up an arrangement include angle based on the layer.

[0050] When the phase contrast layer as a linearly polarized light conversion means described above to the predetermined side of a circular polarization of light detached core is prepared, a polarizing plate is prepared at drawing 3 if needed on the phase contrast layer like instantiation. The polarizing plate can be used for the optical element of this gestalt as a polarizing plate by the side of the light source of a liquid crystal cell. Moreover, a polarizing plate can also be arranged, without preparing a phase contrast layer in the predetermined side of a circular polarization of light detached core. The optical element of this gestaltis [ linearly-polarized-light-] made toize the circular polarization of light which penetrated the circular polarization of light detached core through a polarizing plate, and can use it for the light source side of a liquid crystal cell preferably.

[0051] Although a proper thing can be used as a polarizing plate, generally what consists of a polarization film is used. As an example of a polarization film, the polyene oriented film like a thing, the dehydration processing object of polyvinyl alcohol, or the demineralization acid-treatment object of a polyvinyl chloride which iodine and/or dichromatic dye were made to stick to the film of the hydrophilic giant molecule like a polyvinyl alcohol system, a partial formalized polyvinyl alcohol system, and an ethylene-vinylacetate copolymer system partial saponification object, and was extended is raised. Although the thickness of a polarization film is 5-80 micrometers usually, it is not limited to this. The polarizing plate to be used may be what covered one side or both sides of a polarization film with transparent protection layer etc.

[0052] When it is used with a light guide plate, the diffusion layer prepared in a circular polarization of light detached core if needed equalizes outgoing radiation light, controls light-and-darkness nonuniformity, and when it applies to a liquid crystal cell, it aims at prevention of the check by looking [ GIRAGIRA / check by looking ] by moire arising in interference with a pixel etc. the vertical-incidence light whose phase contrast of the diffusion layer which can be used more preferably than points, such as the maintenance nature of the polarization condition of the light which carried out outgoing radiation from the circular polarization of light detached core, is the wavelength of 633nm -- based on the incident light of less than 30 incident angles, 30nm or less is a 0-20nm thing above all preferably.

[0053] Diffusion layers are methods with arbitrary KUREIZU generating method by the method by surface irregularity-ized processing of the formation method of for example, a particle distribution resin layer, sandblasting, chemical etching, etc., mechanical stress, solvent processing, etc., imprint formation method by the metal mold which established predetermined diffusion structure, etc., and can be suitably formed as a spreading layer, a diffusion sheet, etc. to a circular polarization of light detached core, a phase contrast layer, etc. In addition, a diffusion layer can be arranged between the phase contrast layer prepared in the circular polarization of light detached core, or polarizing plates, and in the location where those top faces etc. are proper the minimum wavelength [ of a circular polarization of light detached core ], and longest wavelength side.

[0054] The polarization light equipment by this invention arranges the circular polarization of light detached core or optical element which described above the incident light from a side face to the outgoing radiation side side of the light guide plate which carries out outgoing radiation

from one side of a vertical side. The example was illustrated to drawing 4. 4 is a light guide plate. According to this polarization light equipment, the light which carried out outgoing radiation from the light guide plate carries out incidence to a circular polarization of light detached core, the circular polarization of light of one of right and left is penetrated, the circular polarization of light of another side is reflected, and re-incidence of the reflected light is carried out to a light guide plate as a return light. It is reflected in the reflex function part which consists of a reflecting layer at the bottom etc., and incidence of the light which carried out re-incidence to the light guide plate is again carried out to a circular polarization of light detached core, and it is again divided into the transmitted light and the reflected light (third-time incident light).

[0055] Therefore, although the re-incident light as the reflected light will be shut up between a circular polarization of light detached core and a light guide plate and will repeat reflection until it turns into the predetermined circular polarization of light which may penetrate a circular polarization of light detached core, in this invention, it is a small number of cycles as much as possible, and the thing of reflection of first-time re-incident light which was made to carry out outgoing radiation repeatedly that there is nothing is more desirable [ incident light ] than points, such as use effectiveness of re-incident light, above all.

[0056] As the aforementioned light guide plate, the proper thing which carries out outgoing radiation of the incident light from a side face from one side of a vertical side can be used. A light guide plate consists of a tabular object which has the vertical side where one of usually becomes an outgoing radiation side, and the vertical face-to-face plane of incidence which consists of a 1 side-edge side at least. The light guide plate which can use preferably than the point to which the return circuit light which led the circular polarization of light which carried out re-incidence through the circular polarization of light detached core to the inferior surface of tongue, phase contrast being uninfluential and maintaining the circular polarization of light condition good, and was reflected on the inferior surface of tongue is made to come out of and put, with the circular polarization of light condition maintained is as much as possible small like the diffusion layer which the phase contrast by the birefringence in the thickness direction described above, and is a 0-20-nm thing especially 30 nm or less above all.

[0057] The structure of excelling also in the outgoing radiation effectiveness of the re-incident light which the gestalt of a light guide plate was excellent in the outgoing radiation effectiveness from an outgoing radiation side, and the outgoing radiation light was excellent in the perpendicularity to an outgoing radiation side, and was easy to use it effectively, and minded the circular polarization of light detached core, and having periodically above all prism-like irregularity more detailed than points, such as approximation nature with the direction of initial outgoing radiation of the direction of outgoing radiation, the heights which consist of a long side and a shorter side side, or a crevice is desirable (Japanese Patent Application No. No. 321036 [ seven to ])). What has the thickness of the side edge section which furthermore counters plane of incidence thinner than that of plane of incidence, and the thing which is 50% or less of thickness above all are desirable.

[0058] Thin-shape-izing of the opposite side edge section to the aforementioned plane of incidence is advantageous at the point which will carry out incidence to the shorter side side of a prism-like concave convex efficiently by the time the light which carried out incidence from plane of incidence results in the opposite side edge section concerned as a transmission edge, carries out outgoing radiation from an outgoing radiation side through the reflection, and can supply incident light to the purpose side efficiently. Moreover, -izing of the light guide plate can be carried out [ lightweight ] by considering as this thin shape-ized structure, for example, when

a prism-like concave convex is a straight line-like, it can consider as about 75% of weight of the light guide plate of homogeneity thickness.

[0059] The heights or the crevice which forms the above mentioned prism-like irregularity is formed periodically usually at the repeating unit of the slant face which consists of the long side and shorter side side of the direction in alignment with plane of incidence. In addition, heights or a crevice has become [ whether the intersection (top-most vertices) of a slant face has projected rather than the straight line concerned, and ] depressed based on the straight line which connects an intersection with the datum level of the slant face which forms it (convex), or (concave) is based.

[0060] Moreover, although the long side and shorter side side of the slant face which forms heights or a crevice are judged based on the straight line which connects an intersection and top-most vertices with datum level, the thing of that of a shorter side side which the projected area to the outgoing radiation side of the long side considers as 5 or more times above all 3 or more times is more desirable than the point which raises the use effectiveness of light. It is still more desirable to arrange so that the long side may be located in the side edge side which counters at a plane-of-incidence side in the case of heights, and counters at plane of incidence in the case of a crevice, therefore to arrange so that a long side may be located in the case of heights and a shorter side side may be located at a plane-of-incidence side in the case of a crevice.

[0061] Transmission light which carries out incidence to a long side and which carries out incidence to a shorter side side through the reflection with the above in addition to the transmission light which carries out direct incidence to a shorter side side can also be supplied to an outgoing radiation side by reflection through the shorter side side (outgoing radiation), and can aim at improvement in efficiency for light utilization. moreover, a desirable projected area [ as opposed to / a long side is a part which functions in order to carry out re-outgoing radiation of the re-incident light reflected by the circular polarization of light detached core, when it considers as polarization light equipment, and / the outgoing radiation side of a long side from this point ] -- 5 or more times of that of a shorter side side -- especially -- ten to 100 times -- it is

[0062] The configuration of the one side of a vertical side or the both sides which prepares the prism-like irregularity of a light guide plate may be determined suitably. As preferably described above, the opposite side edge section is thin-shape-ized rather than plane of incidence as an inclined plane. In that case, the configuration of an inclined plane may be determined as arbitration and can be made into a proper field configuration like a straight-line side or a curved surface. When it is not a straight-line side, it is more desirable than the point which equalizes the direction of outgoing radiation of the outgoing radiation light from an outgoing radiation side that it is in the range of less than 5 times from whenever [ average tilt-angle ] in the total location of the field in which prism-like irregularity is prepared.

[0063] The configuration of prism-like irregularity to establish does not need to be formed on a straight-line-like slant face, either, and may be formed on the slant face including a refracting interface, a curve side, etc. Moreover, neither unevenness nor its configuration of heights or a crevice needs to be the same in the whole prism-like concave convex, and its structure where the configuration and include angle change from an incidence side gradually is more desirable than the point of obtaining the outgoing radiation light which is excellent in perpendicularity.

[0064] The pitch of the heights in a prism-like concave convex or a crevice is so desirable that it is smaller than points, such as control of light-and-darkness nonuniformity, and prevention of moire with a liquid crystal cell, since outgoing radiation light is usually emitted in the shape of a

stripe through the heights or crevice. 500 micrometers or less especially of 300 micrometers or less of periods of the desirable heights in consideration of manufacture precision etc. or a crevice are 5-200 micrometers above all. In addition, a period becomes more nearly deficient in productive efficiency than points, such as manufacture precision, in less than 5 micrometers, and interference and distribution by diffraction increase and it becomes unsuitable for the back light for liquid crystal displays.

[0065] Moreover, as for the above-mentioned long side in the slant face which forms heights or a crevice, it is desirable that the tilt angle to the outgoing radiation side is especially 2 or less times 5 or less times above all 0 to 10 degrees. By considering as the range of this tilt angle, based on the tilt angle of the long side concerned, it is reflected in an outgoing radiation side at a more nearly parallel include angle, and incidence is carried out to a shorter side side, it is reflected [ incidence is carried out to a long side and it is reflected, and ] in it in that case, and the light transmitted at a larger include angle than the tilt angle concerned carries out outgoing radiation from an outgoing radiation side.

[0066] The aforementioned result,-izing of the angle of incidence of the light which carries out incidence to a shorter side side can be carried out [ fixed ], the variation in angle of reflection can be controlled, and YukimitsuTaira-ization of outgoing radiation light can be achieved. Therefore, by adjusting the tilt angle concerned of the long side in the slant face which forms heights or a crevice, and a shorter side side, directivity can be given to outgoing radiation light and it becomes possible to carry out outgoing radiation of the light at a perpendicular direction thru/or the include angle near it to an outgoing radiation side by that cause.

[0067] In the light guide plate which incidentally consists of acrylic resin, the maximum angle of the light to which end-face incident light is transmitted based on the refractive index (about 1.5) is 41.8 degrees, and the maximum angle of the light to which the refractive index of a light guide plate follows on increasing, and is transmitted becomes small. Therefore, the transmission light which the rate of the transmission light which the rate of projected area to the outgoing radiation side of a long side decreases, and can control the direction of outgoing radiation through a long side if the tilt angle of said long side exceeds 10 degrees fell, and carried out incidence to the shorter side side via the long side, The variation in angle of reflection with the transmission light which carried out direct incidence to the shorter side side becomes large, and the controllability which forms outgoing radiation light into Yukimitsu Taira falls, and it becomes scarce at the directivity of outgoing radiation light. In addition, although the tilt angle of the long side concerned becomes disadvantageous for parallel-izing of outgoing radiation light at 0 times, it approves in this invention.

[0068] As for the above-mentioned shorter side side in the slant face which forms heights or a crevice on the other hand, it is desirable that the tilt angle to the outgoing radiation side is 30 degrees or more above all 25 to 50 degrees. By considering as the range of this tilt angle, the transmission light which carries out incidence through direct or a long side can be reflected in a perpendicular or the include angle near it to an outgoing radiation side through the shorter side side, and outgoing radiation of the light of a direction which acts effective in improvement in the visibility of a liquid crystal display etc. can be carried out efficiently.

[0069] About the configuration of the plane of incidence in a light guide plate, there is especially no limitation and it may be determined suitably. Generally, although it considers as a perpendicular field to an outgoing radiation side, improvement in the rate of incident light can also be stretched, for example as a configuration according to the periphery of the light sources, such as a curve concave, etc. Moreover, it can also consider as the plane-of-incidence structure

of having the induction which intervenes between the light sources etc. The induction can be made into a proper configuration according to the light source etc. In addition, although the configuration of an outgoing radiation side has a common flat side etc., it can also prepare detailed prism-like irregularity if needed, and can also establish a diffusion layer. Furthermore, a circular polarization of light detached core can also be directly prepared in the outgoing radiation side of a light guide plate.

[0070] A light guide plate can be formed with the proper ingredient which shows its transparency according to the wavelength field of the light source. Incidentally what shows transparency in [wavelength] about 400-700nm is raised in a light region like the transparency resin represented with the acrylic resin like polymethylmethacrylate, a polycarbonate and the polycarbonate system resin like a polycarbonate polystyrene copolymer, epoxy system resin, etc., for example, glass, etc.

[0071] A light guide plate may be formed by the proper approach. As the manufacture approach more desirable than points, such as mass-production nature. For example, the approach of filling up thru/or casting and carrying out polymerization of the liquefied resin which can carry out polymerization to the mold which can form predetermined prism-like irregularity with heat, ultraviolet rays thru/or a radiation, etc., Approaches, such as injection molding with which the metal mold which can fabricate the resin made to fluidize through the approach of pushing thermoplastics against the bottom of heating to the metal mold which can form predetermined prism-like irregularity, and imprinting a configuration, the thermoplastics which carried out heating melting, or heat and a solvent in a predetermined configuration is filled up, etc. are raised.

[0072] The light guide plate does not need to be formed as a like and may be formed as layered product of dissimilar material etc. and according to one sort of ingredients one-single layer material, although the sheet for prism-like concave convex formation was pasted up on the light guide section which bears transmission of light. In the above-mentioned light guide plate, the property of the angular distribution of outgoing radiation light, field internal division cloth, etc. can be adjusted based on control of the surface ratio of a shorter side and a long side, the configuration of a tilt angle and a prism-like concave convex, curvature, etc.

[0073] Incidentally, a refractive index is the inclined plane where a prism-like concave convex does not have curvature by 1.5, and, in the case of the light guide plate in which initial outgoing radiation light carries out outgoing radiation perpendicularly, re-outgoing radiation of the re-incident light which minded the circular polarization of light detached core by making the tilt angle to the outgoing radiation side of a long side into 6.6 or less degrees can be carried out by include-angle change of less than 10 degrees. Moreover, when a prism-like concave convex has curvature in that case, re-outgoing radiation of the re-incident light concerned can be carried out by include-angle change of less than 10 degrees by having at a rate more than the predetermined area which described above the part from which the tilt angle concerned becomes 6.6 or less degrees.

[0074] Size of a light guide plate, magnitude of the light source, etc. by the purpose of use can determine the thickness of a light guide plate suitably. Especially the general thickness of the light guide plate in the case of using for a liquid crystal display etc. is 0.5-8mm 0.1-10mm above all 20mm or less based on the plane of incidence.

[0075] the opposed face of the outgoing radiation side of a light guide plate -- like the example of drawing -- the need -- responding -- a reflecting layer 41 -- a metallic reflective layer can be arranged preferably. This reflecting layer prevents generating of the leakage light from the



opposed face concerned, is effective in improvement in outgoing radiation effectiveness, and functions as a polarization conversion means of polarization light equipment. You may unite with the opposed face concerned, and a reflecting layer is piled up as a reflective sheet etc., and can take a proper arrangement gestalt in this invention.

[0076] According to the reflecting layer which consists of a metal in the above, reflex time can be made to reverse a polarization property efficiently, and the case where it is based on the total reflection and diffuse reflection the polarization conversion efficiency minded the interface of a refractive-index difference is excelled. When the circular polarization of light incidentally carries out incidence in general at right angles to a metal side, the conversion efficiency of right and left of the circular polarization of light serves as about 100% of value, and shows 90% or more of conversion efficiency even in 30 incident angles.

[0077] A metallic reflective layer more desirable than the point of polarization conversion efficiency has a metal side containing at least one sort of the metal of a high reflection factor which consists of aluminum, silver, gold, copper, or chromium. The metallic reflective layer which is excellent in adhesion with the opposed face of the outgoing radiation side of a light guide plate can be formed as the mixing coating layer of the metal powder by binder resin, an attachment layer of the metal thin film by a vacuum evaporation method etc., etc. The metallic reflective layer may be formed as a multilayer interference thin film etc., and can also prepare the proper coat layer aiming at improvement in a reflection factor, antioxidizing, etc. in the one side or both sides if needed.

[0078] In addition, about a reflecting layer, it can replace with the aforementioned reflecting layer 41, or a reflecting plate can also be formed along with the opposed face of the outgoing radiation side of a light guide plate with the reflecting layer. The method which forms a reflecting plate in the opposed face concerned of a light guide plate has the advantage which can make small the re-outgoing radiation angle of the re-incident light through a circular polarization of light detached core, when the tilt angle of a long side is the same. About the reflecting plate, it can apply to the aforementioned reflecting layer correspondingly, and the reflecting plate which has a metallic reflection side can use preferably. Therefore, as a reflecting plate, proper things, such as a resin sheet which attached the metal thin film, and a metallic foil, a metal plate, can be used. The front face of a reflecting plate does not make it indispensable to be a mirror plane, but, on the whole, may be formed in homogeneity as two or more pages, a continuation curved surface, etc. of a small include angle.

[0079] Moreover, the thing of less than 5 times has above all the half width of the half-value width of the breadth of the angle of reflection of the reflected light at the time of carrying out incidence of the parallel light more desirable as a reflecting plate than the point which controls the breadth of re-outgoing radiation light less than 10 degrees. Therefore, as a reflecting plate, a reflection factor is high and the breadth of angle of reflection can use a small proper thing. It has a rough front face by irregularity, a reduction roll, etc., and you may make it the angle of reflection of the reflected light spread a little.

[0080] According to the above-mentioned light guide plate, various equipments, such as a liquid crystal display which can carry out outgoing radiation of the light made parallel with high precision using it in the direction which is excellent in perpendicularity advantageous to a check by looking, and can obtain the polarization light equipment which is excellent in brightness, using the light from the light source efficiently, as a result is excellent in low-power nature it is bright and legible, can be formed. In addition, as a light guide plate, a match can use [ the wavelength region of the outgoing radiation light based on it, and the wavelength region of light



which a circular polarization of light detached core reflects as the circular polarization of light besides predetermined ] preferably as much as possible.

[0081] The back light of a side light mold is formed like the example of drawing by arranging the light source 42 to the plane of incidence of a light guide plate usually. Although a thing proper as the light source can be used, array objects, such as the shape of the point light source of the linear light source of a cathode-ray tube etc., light emitting diode, etc., its line, or a field, etc. can use preferably, for example (cold, heat). On the occasion of formation of the back light concerned, it can also consider as the combination object which has arranged proper auxiliary means, such as the light source holder 43 which surrounds the light source in order to lead the emission light from a linear light source to the side face of a light guide plate like the example of drawing if needed, and a prism sheet for the outgoing radiation directional control of light.

[0082] In addition, generally as a light source holder, a resin sheet, a metallic foil, etc. which attached the high reflection factor metal thin film are used. When pasting up a light source holder on the edge of a light guide plate through adhesives etc., formation of prism-like irregularity can also be omitted about a part for the jointing. Moreover, a light source holder can be installed in the predetermined side of a light guide plate, and it can also be made to serve as a reflecting plate.

[0083] The light guide plate which can be preferably used for formation of polarization light equipment While the directivity is made to carry out outgoing radiation of the incident light from a side face from an outgoing radiation side at high effectiveness, and the outgoing radiation light excels [ directivity ] in high directivity and perpendicularity [ as opposed to an outgoing radiation side above all ] is shown Reflection repeats the re-incident light which it excelled in the re-outgoing radiation effectiveness of the re-incident light through a circular polarization of light detached core, and the directivity of the re-outgoing radiation light and an outgoing radiation include angle were as much as possible in agreement with the directivity of initial outgoing radiation light, and an outgoing radiation include angle, and minded the circular polarization of light detached core, and it is made to carry out outgoing radiation with a small reflective number of cycles above all that there is nothing.

[0084] The polarization light equipment by this invention changes the outgoing radiation light into the optical condition which contains a linearly polarized light component richly through a phase contrast layer etc. if needed, a polarizing plate is made easy to penetrate, and it prevents [ a reflective loss etc. is prevented by reusing the reflected light (re-incident light) by the circular polarization of light detached core as an outgoing radiation light by polarization conversion, ] an absorption loss, and enables it to aim at improvement in efficiency for light utilization as mentioned above. Although the quantity of the quantity of light which penetrates a polarizing plate ideally may be increased twice [ about ] with this method, it is more desirable than the point used as the light source that the linearly polarized light component which may penetrate a polarizing plate is included 70% or more above all 65% or more.

[0085] Like the above, it can be excellent in the use effectiveness of light, and the polarization light equipment by this invention is bright, and it can excel in perpendicularity, and light with little light-and-darkness nonuniformity can be offered, and it can use it for various equipments preferably as a back light system in a liquid crystal display etc. from large-area-izing etc. being easy.

[0086] The liquid crystal display 6 which used the polarization light equipment 5 by this invention for the back light system at drawing 5 was illustrated. For a lower polarizing plate and 62, a liquid crystal cell and 63 are [ 61 / an upper polarizing plate and 64 ] the diffusion plates for

compensation. The lower polarizing plate 61 and the diffusion plate 64 for compensation are formed if needed.

[0087] A liquid crystal display is formed by generally assembling suitably component parts, such as a driving gear of accompanying in the liquid crystal cell and it which function as a liquid crystal shutter, a polarizing plate, a back light, and a phase contrast plate for compensation as occasion demands, etc. In this invention, except for the point using the above-mentioned polarization light equipment, there is especially no limitation and it can be formed according to the former. Especially, the liquid crystal display of a direct viewing type can be formed preferably.

[0088] Therefore, there is especially no limitation about the liquid crystal cell to be used, and a proper thing can be used. Although it is used in favor of what displays above all by carrying out incidence of the light of a polarization condition to a liquid crystal cell, for example, can use for the liquid crystal cell using a twist nematic liquid crystal or a super twist nematic liquid crystal etc. preferably, the liquid crystal and dichromatic dye of a non-twisting system can be used for the liquid crystal cell using the liquid crystal of the guest host system distributed in liquid crystal, or a ferroelectric liquid crystal etc. There is especially no limitation also about the drive method of liquid crystal.

[0089] In addition, the liquid crystal display which used what has high degree of polarization is more desirable than especially the point of obtaining the display of the good contrast ratio by the incidence of the advanced linearly polarized light, as a polarizing plate by the side of a back light as a polarizing plate like the absorption mold linearly polarized light child of for example, an iodine system or a color system etc. On the occasion of formation of a liquid crystal display, proper optical layers, such as a diffusion plate formed, for example on the polarizing plate by the side of a check by looking, an anti glare layer, an antireflection film and a protective layer, a guard plate, or a phase contrast plate for compensation formed between a liquid crystal cell and a polarizing plate, can be arranged suitably.

[0090] The aforementioned phase contrast plate for compensation aims at compensating the wavelength dependency of a birefringence etc. and aiming at improvement in visibility etc. In this invention, it is arranged if needed between the polarizing plate by the side of a check by looking or/and a back light, and a liquid crystal cell etc. In addition, as a phase contrast plate for compensation, a proper thing can be used according to a wavelength region etc., and it may be formed as a superposition layer more than one layer or two-layer. The phase contrast plate for compensation can be obtained as an oriented film of instantiation etc. with the above-mentioned phase contrast plate for linearly polarized light conversion.

[0091] in this invention, laminating unification is carried out on the whole or partially, and the optical element thru/or components which forms the above-mentioned polarization light equipment and a liquid crystal display fixes -- having -- \*\*\*\* -- separation -- you may arrange in the easy condition. On the occasion of formation of a liquid crystal display etc., the outgoing radiation light which is excellent in perpendicularity or Yukimitsu Taira nature is supplied, the re-incident light through a circular polarization of light detached core is also in a condition with little the loss and include-angle change by dispersion etc., and the consistency of the direction of initial outgoing radiation light improves re-outgoing radiation, and the polarization light equipment which supplies efficiently the outgoing radiation light of a direction effective in improvement in visibility can use preferably.

[0092]

[Example]

It heated after membrane formation (3 micrometers in thickness) by the spin coat method, and the glass transition temperature which has the principal chain of example of reference 1 acrylic heated the side-chain mold cholesteric-liquid-crystal polymer which is 57 degrees C for 2 minutes at 120 more degrees C after heating for 30 seconds by 140 degrees C to the polyimide rubbing processing side of a triacetyl cellulose film with a thickness of 10 micrometers, and quenched it to it, and the circular polarization of light division plate of the blue system which presents a mirror plane-like selective reflection condition was obtained. The main wavelength of selective reflection was 450nm, and this was what penetrates the left-handed circularly-polarized light.

[0093] It heated after membrane formation (3 micrometers in thickness) by the spin coat method, and the glass transition temperature which has the principal chain of example of reference 2 acrylic heated the side-chain mold cholesteric-liquid-crystal polymer which is 64 degrees C for 2 minutes at 130 more degrees C after heating for 30 seconds by 150 degrees C to the polyimide rubbing processing side of a triacetyl cellulose film with a thickness of 10 micrometers, and quenched it to it, and the circular polarization of light division plate of the green system which presents a mirror plane-like selective reflection condition was obtained. The main wavelength of selective reflection was 550nm, and this was what penetrates the left-handed circularly-polarized light.

[0094] It heated after membrane formation (3 micrometers in thickness) by the spin coat method, and the glass transition temperature which has the principal chain of example of reference 3 acrylic heated the side-chain mold cholesteric-liquid-crystal polymer which is 75 degrees C for 2 minutes at 145 more degrees C after heating for 30 seconds by 170 degrees C to the polyimide rubbing processing side of a triacetyl cellulose film with a thickness of 10 micrometers, and quenched it to it, and the reddish circular polarization of light division plate which presents a mirror plane-like selective reflection condition was obtained. The main wavelength of selective reflection was 650nm, and this was what penetrates the left-handed circularly-polarized light.

[0095] The adhesion laminating of the circular polarization of light division plate obtained in the example 1 of example 1 reference, the example 2 of reference, and the example 3 of reference was carried out in a blue system, a green system, and reddish sequence, and the circular polarization of light division plate of a superposition mold was obtained, it has arranged so that it may become a left-handed-circularly-polarized-light plate about a polarizing plate through a broadband quarter-wave length plate on the reddish circular polarization of light division plate, and the optical element was obtained.

[0096] Example of comparison 1 1 / 4 wavelength plate and the polarizing plate have been arranged to the circular polarization of light division-plate side of a blue system, and also the optical element was obtained according to the example 1.

[0097] The quarter-wave length plate and the polarizing plate have been arranged to the green system side, and also location sequence of an example of comparison 2 circular-polarization-of-light division plate was made into reddish, the blue system, and the green system, and the optical element was obtained according to the example 1.

[0098] The quarter-wave length plate and the polarizing plate have been arranged to the blue system side, and also location sequence of an example of comparison 3 circular-polarization-of-light division plate was made into a green system, reddish, and a blue system, and the optical element was obtained according to the example 1.

[0099] The quarter-wave length plate and the polarizing plate have been arranged to the reddish side, and also location sequence of an example of comparison 4 circular-polarization-of-light

division plate was made a green system and blue system and reddish, and the optical element was obtained according to the example 1.

[0100] The quarter-wave length plate and the polarizing plate have been arranged to the green system side, and also location sequence of an example of comparison 5 circular-polarization-of-light division plate was made into a blue system, reddish, and a green system, and the optical element was obtained according to the example 1.

[0101] The polarizing plate side was turned up, the optical element obtained in the evaluation trial example and the example of a comparison has been arranged on the surface light source of uniform brightness, the chromaticity change by change of a viewing angle was measured, and law estimated five points. Five points mean that there are few viewing-angle dependencies, therefore the small thing of the color change by the viewing angle.

[0102] The aforementioned result was shown in degree table.

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TECHNICAL FIELD

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[Field of the Invention] This invention is excellent in brightness at the circular polarization of light detached core which prevented the color change by the viewing angle of a cholesteric-liquid-crystal layer and the polarization light equipment which is excellent in the efficiency for light utilization using it, and a list, and relates to the liquid crystal display of right visibility.

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PRIOR ART

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[Background of the Invention] The lighting system which prepares a reflecting layer in the inferior surface of tongue of the light guide plate of the side light mold which was made to carry out outgoing radiation from one side of the upper and lower sides of the incident light from a side face, prepares the circular polarization of light detached core which consists of a cholesteric-liquid-crystal layer in an outgoing-radiation side, separates into the transmitted light and the reflected light which consist of the circular polarization of light of right and left of incident light through the circular polarization of light detached core, is made to reflect the reflected light through a reflecting layer at the bottom conventionally, and was made to carry out re-outgoing radiation from an outgoing-radiation side was proposed (JP,3-45906,A, JP,6-324333,A, JP,7-36032,A).

[0003] Since it is deficient in the light which about 55% of light guide plate outgoing radiation light is absorbed, and can be used effectively in case it penetrates a polarizing plate with the usually light of unpolarized light, this lighting system is carried out as [ supply / by considering light as polarization / a polarizing plate ], prevents absorption by the polarizing plate and aims at this aiming at improvement in efficiency for light utilization, and raising the brightness of a liquid crystal display etc. The wavelength ( $\lambda$ ) of the reflected light through the aforementioned circular polarization of light detached core is expressed with formula:  $\lambda = \frac{p}{\cos \theta}$  based on Tsunemitsu, the rate of abnormality optical refraction ( $n_o$ ,  $n_e$ ), and spiral pitch ( $p$ ) by the birefringence of a cholesteric-liquid-crystal layer, when an incident angle is set to  $\theta$ .

[0004] Since above  $n_o$  and  $n_e$  are not large values, usually, the wavelength field of the reflected light is narrower than a light field, and the transmitted light and the reflected light through the cholesteric-liquid-crystal layer of a monolayer can color and be seen, and are called selective reflection nature and circular dichroism. Although the attempt which changes the pitch of a cholesteric-liquid-crystal layer in the thickness direction, and extends the wavelength field of the reflected light also occurs (JP,6-281814,A), the approach of neutral-colors-izing said coloring is taken as a circular polarization of light detached core which superimposed two or more cholesteric-liquid-crystal layers from which the wavelength field of the reflected light generally differs (JP,1-133003,A).

[0005] However, when changing a viewing angle, and outgoing radiation light blue-ized and changed the viewing angle further, there was a trouble of color change of carrying out reddening in the circular polarization of light detached core of the above mentioned superposition mold. Although there is also a proposal which a foreground color shifts to a blue side, therefore sets up the bright-line-spectrum wavelength of an emitter in the core and the middle of a short wavelength edge of the reflected wave length by the circular polarization of light detached core when it applies to a liquid crystal display by using a circular polarization of light detached core as a back light system (JP,7-36025,A), the solution of the color change by the aforementioned viewing-angle change does not become.

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## EFFECT OF THE INVENTION

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[Effect of the Invention] By the above-mentioned configuration which superimposed two or more cholesteric-liquid-crystal layers as the sequence of the merits and demerits of reflected wave length, a circular polarization of light detached core with a small color change of the outgoing radiation light by viewing-angle change can be obtained, and the polarization light equipment which is excellent in efficiency for light utilization using it, as a result the liquid crystal display which is bright and is excellent in visibility can be obtained. Although the reason outgoing radiation light carries out color change by viewing-angle change may be for penetrating a circular polarization of light detached core as polarization, the reason the color change by viewing-angle change is controlled by the aforementioned superposition method not certain therefore is unknown.

[0009]

[Embodiment of the Invention] The circular polarization of light detached core of this invention superimposes two or more cholesteric-liquid-crystal layers from which reflected wave length differs based on the main wavelength of the reflected light as the sequence of merits and demerits. The example was shown in drawing 1. 1 is a circular polarization of light detached core, and 12, 14 and 16 are [ 11, 13, and 15 ] support base materials.

[0010] As a cholesteric-liquid-crystal layer, the proper thing which divides the natural light into the circular polarization of light on either side as the transmitted light and the reflected light by GURANJAN orientation can be used. Incidentally as the example, the sheet which has the layer which has a cholesteric-liquid-crystal phase, and the layer which consists of a liquid crystal polymer which presents a cholesteric phase above all, the sheet which developed the layer concerned on the glass plate etc., or the film which consists of a liquid crystal polymer which presents a cholesteric phase is raised.

[0011] As for a cholesteric-liquid-crystal layer, in the above, it is desirable to carry out orientation to homogeneity as much as possible. The cholesteric-liquid-crystal layer of homogeneity orientation offers the reflected light without dispersion, is advantageous to expansion of the angle of visibility of a liquid crystal display etc., and suitable for formation of the direct viewing type liquid crystal display by which direct observation is especially carried out also from across.

[0012] The circular polarization of light detached core by this invention can form two or more cholesteric-liquid-crystal layers from which reflected wave length differs by superimposing two-layer or three layers or more as the sequence of merits and demerits based on the main wavelength of the reflected light. Superposition-ization of this cholesteric-liquid-crystal layer is aimed at extensive wavelength region-ization of isolation.

[0013] Namely, although a limitation is located in the wavelength region which shows selective-reflection nature (circular dichroism) and the limitation also has usually the case of the large range which reaches about 100nm wavelength region in the cholesteric-liquid-crystal layer of a monolayer, since it is less than the whole region of the light desired when applying to a liquid crystal display etc. also in the wavelength range, it aims at making the wavelength region which is made to superimpose the cholesteric-liquid-crystal layer from which selective-reflection nature (reflected wave length) differs, and shows circular dichroism expand in such a case.

[0014] It is the combination which reflects the circular polarization of light of the same direction,

and the cholesteric-liquid-crystal layer which is incidentally in the range whose main wavelength of selective reflection is 300-900nm can be used in the combination from which the main wavelength of selective reflection differs, and combination which is different 30-200nm above all, respectively, and the circular polarization of light detached core which can cover the wavelength region where a light region etc. is large by superimposing the 2-6 kinds can be formed efficiently. Especially as an object for the lights, that on which reflected wave length superimposed three sorts of cholesteric-liquid-crystal layers, a blue network, a green network, and a red network, is more desirable than points, such as thin-shape-izing by the small number of superposition.

[0015] It aims at increase in quantity of the polarization in the condition that it can prevent and use that the point used as a superposition object in the combination of what reflect the circular polarization of light of the same above mentioned polarization direction will be in a polarization condition which arranges the phase condition of the circular polarization of light reflected on each class, and is different in each wavelength region.

[0016] A proper thing may be used for the cholesteric liquid crystal which forms a circular polarization of light detached core, and there is especially no limitation in it. Therefore, various things, such as a principal chain mold with which the straight-line-like atomic group (meso gene) of the conjugate property which gives a liquid crystal stacking tendency was introduced into the principal chain and side chain of a polymer, and a side-chain mold, can be used. The wavelength region of selective reflection becomes large and the larger cholesteric-liquid-crystal molecule of phase contrast can be used more preferably than points, such as allowances over mitigation of a number of layers, or the wavelength shift at the time of a large angle of visibility. Moreover, rather than weight or the point of \*\*\*\*\*, a liquid crystal polymer can use preferably. Furthermore, as the liquid crystal polymer, that whose glass transition temperature is 30-150 degrees C can use preferably from points, such as handling nature and the stability of the orientation in operating temperature.

[0017] Incidentally, as an example of the liquid crystal polymer of the above mentioned principal chain mold, it has the structure which combined the meso gene radical which minds the spacer section which gives flexibility if needed, and consists of a Para permutation ring compound etc., for example, polymers, such as a polyester system, a polyamide system, a polycarbonate system, and a polyester imide system, are raised.

[0018] Moreover, a thing, a nematic system liquid crystal polymer of low-molecular chiral agent content, a liquid crystal polymer of chiral component installation, a mixed liquid crystal polymer of a nematic system and a cholesteric system, etc. which have the low-molecular-liquid-crystal compound (meso gene section) which makes polyacrylate, polymethacrylate, a polysiloxane, poly malonate, etc. a principal chain frame, minds the spacer section which consists of an atomic group of conjugate property as a side chain as an example of the liquid crystal polymer of a side-chain mold if needed, and consists of a Para permutation ring compound etc. are raised.

[0019] Like the above, it can consider as the thing of a cholesteric stacking tendency with the method which introduces the proper chiral component which consists of a compound which has asymmetrical carbon also in what has the Para permutation ring compound which gives the nematic stacking tendency which consists of the Para permutation aromatic-series unit, the Para permutation cyclohexyl ring unit, etc. like for example, an azomethine form, an azo form, an AZOKISHI form and an ester form, a biphenyl form and a phenylcyclohexane form, and a bicyclo hexane form, a low-molecular chiral agent, etc. (JP,55-21479,A, U.S. Pat. No. 5332522, etc.). In addition, a cyano group, the alkyl group, alkoxy group of the end substituent in the para

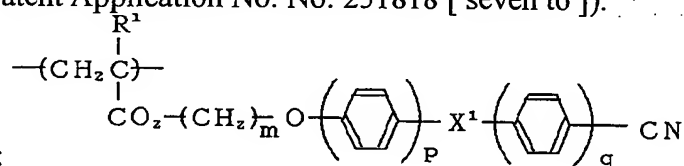


position in the Para permutation ring compound, etc. may be proper.

[0020] Moreover, as the spacer section, for example, polymethylene chain-(CH<sub>2</sub>) n-, polyoxymethylene chain-(CH<sub>2</sub>CH<sub>2</sub>O) m-, etc. which show flexibility are raised. the chemical structure of the meso gene section etc. determines suitably the number of cycles of the structural unit which forms the spacer section -- having -- general -- the case of a polymethylene chain -- n -- 0-20, and the case where they are 2-12, and a polyoxymethylene chain above all -- m -- 0-10 -- it is 1-3 above all.

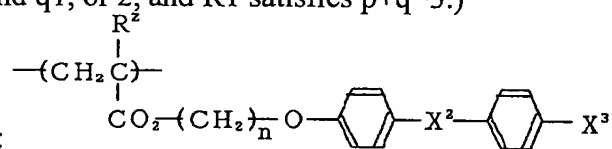
[0021] In addition, the proper method according to the usual polymer composition to which copolymerization for example, of the component monomer is carried out with a radical polymerization method, a cationic polymerization method, an anionic polymerization method, etc. can perform preparation of the above-mentioned principal chain mold liquid crystal polymer. Moreover, the monomer addition polymerization method which polymer-izes the monomer to which preparation of a side-chain mold liquid crystal polymer also introduced the meso gene radical into the monomer for vinyl system principal chain formation like the ester of an acrylic acid or a methacrylic acid through the spacer radical if needed by a radical polymerization method etc., The method which carries out the addition reaction of the vinyl permutation meso gene monomer to the bottom of existence of a platinum system catalyst through Si-H association of polyoxy methyl silylene, The method which introduces a meso gene radical by the esterification reaction using a correlation migration catalyst through the functional group given to the principal chain polymer, A method with the proper method which carries out a polycondensation reaction can perform the monomer which introduced the meso gene radical into some malonic acids through the spacer radical if needed, and diol.

[0022] In the above Membrane formation nature and the good GURANJAN stacking tendency of a mono-domain condition, The short-time nature of orientation processing, the stable stability to a vitreous state, the controllability of the spiral pitch of a cholesteric phase, The liquid crystal polymer which can be used more preferably than points, such as the plasticity of the circular polarization of light detached core which orientation conditions, such as a pitch, cannot change easily due to operating temperature, and is lightly [ it is thin and ] excellent in endurance or preservation stability the copolymer which uses as a component the monomeric unit expressed with the following general formula (a), and the monomeric unit expressed with a general formula (b) -- above all with 60 - 95 % of the weight of monomeric units of a general formula (a) Let the copolymer which consists of 40 - 5 % of the weight of monomeric units of a general formula (b) be a component (Japanese Patent Application No. No. 251818 [ seven to ]).



[0023] General formula (a) :

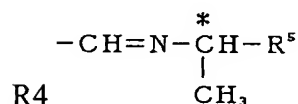
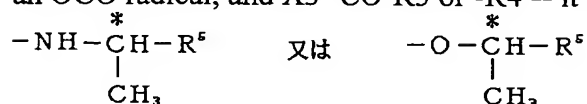
(However, the integer of 1-6 and X1 are two COs or an OCO radical, and hydrogen or a methyl group, and m are p and q1, or 2, and R1 satisfies p+q=3.)



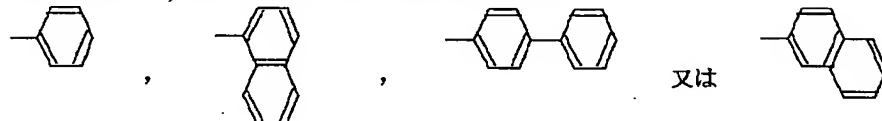
General formula (b) :

R2 [ however, ] -- hydrogen or a methyl group, and n -- the integer of 1-6, and X2 -- two COs or

an OCO radical, and X3 -CO-R3 or -R4 -- it is -- the R3



It comes out, and it is and R5 is as follows.



[0024] The acrylic monomer which can form the monomeric unit expressed with the aforementioned general formula (a) and a general formula (b) is compoundable by the proper approach. As the example, first ethylene chlorohydrin and 4-hydroxybenzoic acid After carrying out heating reflux in an alkali water solution by making potassium iodide into a catalyst and obtaining hydroxycarboxylic acid, Carry out dehydration of it to an acrylic acid or a methacrylic acid, and it considers as acrylate (meta). By esterifying the (meta) acrylate under existence of DCC (dicyclohexylcarbodiimide) and DMAP (dimethylamino pyridine) by the 4-cyano-4'-hydroxy biphenyl, the method of obtaining the monomer belonging to a general formula (a) raises, and it is \*\*\*\*.

[0025] moreover, as a synthetic example of the acrylic monomer belonging to a general formula (b) After carrying out the heating reflux of hydroxyalkyl halide and the 4-hydroxybenzoic acid in an alkali water solution by making potassium iodide into a catalyst first and obtaining hydroxycarboxylic acid, Dehydration of it is carried out to an acrylic acid or a methacrylic acid. As acrylate (meta) the acrylate (meta) of *Perilla frutescens* (L.) Britton var. *crispa* (Thunb.) Decne. The approach of esterifying under existence of DCC and DMAP, the approach of esterifying the (meta) acrylate under existence of DCC and DMAP after the aforementioned dehydration with the phenol which has an asymmetrical carbon radical in the 4th place, etc. are raised with the phenol which has CO radical of R three-set content in the 4th place.

[0026] Therefore, other monomers belonging to an aforementioned general formula (a) and an aforementioned general formula (b) are compoundable according to the above using the proper raw material which has the introductory target radical. In addition, the phenol which has CO radical of R three-set content in the 4th aforementioned place For example, make methyl chloroformate and 4-hydroxybenzoic acid react in an alkali water solution first, and it considers as a carboxylic acid. After making it into acid chloride by oxalyl chloride, by the approach of making it reacting with H-R3 in a pyridine/tetrahydrofuran, introducing R3 set, processing it with aqueous ammonia subsequently, and removing a protective group etc. Moreover, the phenol which has an asymmetrical carbon radical in the 4th place can be obtained by the approach of carrying out azeotropy dehydration of for example, a 4-hydroxy benzaldehyde and the (S)-(-)-1-phenyl ethylamine in toluene etc.

[0027] The above-mentioned copolymer can change the spiral pitch of cholesteric liquid crystal by changing the content of the monomeric unit expressed with the general formula (b). Therefore, the wavelength which shows circular dichroism by control of the content of the monomeric unit expressed with a general formula (b) can be adjusted, and the optical element

which shows circular dichroism to the light of a light region can also be obtained easily.

[0028] Formation of the cholesteric-liquid-crystal layer by the liquid crystal polymer can be performed by the approach according to the conventional orientation processing. Incidentally as the example, on a support base material, polyimide and polyvinyl alcohol, The orientation film which formed film, such as polyester, polyarylate and polyamidoimide, and polyether imide, and carried out rubbing processing with the rayon cloth etc., A liquid crystal polymer is developed on the proper orientation film which consists of a method vacuum evaporationo layer of slanting of SiO<sub>2</sub>, or orientation film by extension processing. Or more than glass transition temperature It heats under to isotropic phase transition temperature, after the liquid crystal polymer molecule has carried out GURANJAN orientation, it cools under to glass transition temperature, and it considers as a vitreous state, and the approach of forming the flozen layer by which the orientation concerned was fixed etc. is raised.

[0029] As the aforementioned support base material, proper things, such as a monolayer which consists of plastics like triacetyl cellulose, polyvinyl alcohol and polyimide, polyarylate and polyester, a polycarbonate, polysulfone and polyether sulphone, amorphous polyolefine and a denaturation acrylic polymer, and epoxy system resin, for example, a laminated film, or a glass plate, can be used. Plastic film is more desirable than points, such as thin-shape-izing, and a small thing has the phase contrast as much as possible more desirable than points, such as improvement in the use effectiveness of the light by prevention of change of a polarization condition, by the birefringence.

[0030] Expansion of a liquid crystal polymer can carry out thin layer expansion of the solution by the solvent of a liquid crystal polymer by proper approaches, such as a spin coat method, the roll coat method, the flow coat method and the printing method, a dip coating method and the flow casting forming-membranes method, the bar coat method, and gravure, and can be performed by the approach of carrying out desiccation processing of it if needed etc. As the aforementioned solvent, proper things, such as a methylene chloride, a cyclohexanone and a trichloroethylene, tetrachloroethane and N-methyl pyrrolidone, and a tetrahydrofuran, can be used, for example.

[0031] Moreover, the heating melt of a liquid crystal polymer and the heating melt in the condition of presenting an isotropic phase preferably can be developed according to the above, and the approach which does not use solvents, such as an approach which develops to a thin layer and it is made to solidify further, maintaining the melting temperature if needed, therefore the health nature of work environment, etc. can develop a liquid crystal polymer also by the good approach. In addition, on the occasion of expansion of a liquid crystal polymer, the superposition method of the cholesteric-liquid-crystal layer which minded the orientation film if needed for the purpose of thin-shape-izing etc. can be taken.

[0032] Heat-treatment for carrying out orientation of the expansion layer of a liquid crystal polymer can be performed by heating to the temperature requirement from the glass transition temperature of a liquid crystal polymer to isotropic phase transition temperature, i.e., the temperature requirement where a liquid crystal polymer presents a liquid crystal phase, as described above. Moreover, immobilization of an orientation condition can be performed by cooling under to glass transition temperature, and there is especially no limitation about the cooling condition. Usually, since the aforementioned heat-treatment can be performed at the temperature of 300 degrees C or less, generally a natural-air-cooling method is taken.

[0033] The flozen layer of the liquid crystal polymer formed on the support base material can be used for a circular polarization of light detached core as it is as an one object with a support base

material, and can also be used as a circular polarization of light detached core which exfoliates from Japanese lacquer and a support base material, and consists of a film etc. When forming as an one object with the support base material which consists of a film etc., it is more desirable than points, such as the tightness of the change of state of polarization, that phase contrast uses a small support base material as much as possible.

[0034] Especially the thickness of a cholesteric-liquid-crystal layer has 2-10 micrometers more desirable than points, such as a size of turbulence of orientation, prevention of a permeability fall, and the wavelength range of selective reflection, 1-30 micrometers above all 0.5-50 micrometers. Moreover, it is more desirable than points, such as thin-shape-izing of a circular polarization of light detached core, that 2-50 micrometers of 3-30 micrometers of total thickness of each cholesteric-liquid-crystal layer are 5-10 micrometers especially above all. When it furthermore has a support base material, it is desirable that 20-200 micrometers of 25-150 micrometers of total thickness including the base material are 30-100 micrometers especially above all. On the occasion of formation of a circular polarization of light detached core, the various additives which become a cholesteric-liquid-crystal layer from a stabilizer, a plasticizer, or metals can be blended if needed.

[0035] The circular polarization of light detached core used in this invention can be made into a gestalt with proper cel gestalt which pinched the cholesteric-liquid-crystal layer which consists for example, of a low-molecular-weight object with transparence base materials, such as glass and a film, gestalt which supported the cholesteric-liquid-crystal layer which consists of a liquid crystal polymer with the transparence base material, gestalt which consists of a film of the liquid crystal polymer of a cholesteric-liquid-crystal layer, gestalt which superimposed those gestalt objects in proper combination.

[0036] In the aforementioned case, a cholesteric-liquid-crystal layer can also be held according to the reinforcement, operability, etc. with the support base material more than one layer or two-layer. the point of preventing the change of state of polarization in using the support base material more than two-layer etc. -- for example, the film of non-orientation -- even if it carries out orientation, a small thing can use [ phase contrast ] preferably as much as possible like the small triacetate film of a birefringence etc. Gestalten more desirable than points, such as thin-shape-izing, are the gestalt supported with the transparence base material, a gestalt which consists of a film of a liquid crystal polymer.

[0037] In addition, as for each class of superposition, being formed as a flat layer is more desirable than the point that a circular polarization of light detached core copes with equalization of the above-mentioned separability ability, and the wavelength shift of oblique-incidence light etc. Use of a liquid crystal polymer is more advantageous to especially superposition of a cholesteric-liquid-crystal layer than points, such as manufacture effectiveness and thin-film-izing. Superposition processing can take proper methods, such as every mere pile and adhesion through adhesives, such as a binder.

[0038] In this invention, one sort of proper optical layers, such as a phase contrast layer, a polarizing plate, and a diffusion layer, or two sorts or more can be arranged, and various optical elements can be formed in the cholesteric-liquid-crystal layer side of the longest wavelength which becomes the optical outgoing radiation side of a circular polarization of light detached core. The example was shown in drawing 2 and drawing 3 . 2 is a phase contrast layer and 3 is a polarizing plate.

[0039] A phase contrast layer functions as a linearly polarized light conversion means, the circular polarization of light which carried out outgoing radiation from the circular polarization

of light detached core carries out incidence to a phase contrast layer, a phase change is received, the light of the wavelength on which the phase change is equivalent to quarter-wave length is changed into the linearly polarized light, and other wavelength light is changed into elliptically polarized light. The changed elliptically polarized light turns into such flat elliptically polarized light that it is close to the wavelength of the light changed into the aforementioned linearly polarized light. Outgoing radiation of the light in the condition that many linearly polarized light components which may penetrate a polarizing plate are included will be carried out as a result of [ this ] a phase contrast layer.

[0040] By changing into a condition with many linearly polarized light components, it can consider as the light which is easy to penetrate a polarizing plate. In the case of a liquid crystal display, this polarizing plate functions as the optical layer which prevents the fall of the polarization property generated in change of the angle of visibility to a liquid crystal cell, and maintains display grace, an optical layer which realizes more advanced degree of polarization and attains better display grace.

[0041] That is, in the above, although it is possible to carry out incidence of the outgoing radiation polarization [ detached core / circular polarization of light ] to a liquid crystal cell as it is, and to attain a display, without using a polarizing plate, since improvement in the display grace described above by minding a polarizing plate etc. can be aimed at, a polarizing plate may be used if needed. In that case, it is so more advantageous that the permeability to a polarizing plate is high than the point of the brightness of a display, and since the permeability becomes so high that many linearly polarized light components of the polarization direction which is in agreement with the polarization shaft (transparency shaft) of a polarizing plate are included, outgoing radiation polarization [ detached core / circular polarization of light ] is changed into the predetermined linearly polarized light through a linearly polarized light conversion means for the purpose of it.

[0042] The liquid crystal display which can obtain the permeability which exceeds 80% when a polarization shaft is made in agreement and incidence of the linearly polarized light is carried out, therefore whose use effectiveness of light improves sharply, and is incidentally excellent in brightness although the permeability is about 43% when incidence of the natural light or the circular polarization of light is carried out to a usual iodine system polarizing plate becomes possible. Moreover, in this polarizing plate, the degree of polarization which reaches to 99.99% can also be attained. If independent, this achievement of high degree of polarization is difficult, and the degree of polarization especially to the incident light from slant which is a circular polarization of light detached core tends to fall.

[0043] While it is equivalent to the phase contrast of quarter-wave length in the circular polarization of light which carried out outgoing radiation and being able to form many linearly polarized lights from a circular polarization of light detached core as a phase contrast layer, what can change the light of other wavelength into the flat elliptically polarized light near the linearly polarized light as much as possible [ have the major-axis direction in the parallel direction as much as possible with said linearly polarized light, and ] is desirable. A phase contrast layer can also be prepared [ polarizing plate ] in one with a circular polarization of light detached core.

[0044] By using the phase contrast layer like the above, it can arrange so that the direction of the linearly polarized light of the outgoing radiation light and the major-axis direction of elliptically polarized light may become parallel as much as possible with the transparency shaft of a polarizing plate, and the light of a condition with many linearly polarized light components which may penetrate a polarizing plate can be obtained. A phase contrast layer can be formed

with the proper quality of the material, what gives transparent and uniform phase contrast is desirable, and, generally a phase contrast plate is used.

[0045] The phase contrast given in a phase contrast layer can be suitably determined according to the wavelength region of the circular polarization of light by which outgoing radiation is carried out etc. from a circular polarization of light detached core. Incidentally, from points, such as wavelength range and conversion efficiency, it also considers that it is that almost all the phase contrast plate indicates the wavelength dispersion of a forward birefringence to be from the quality-of-the-material property, and a thing with the small phase contrast and the thing which gives phase contrast 110-150nm or less especially can use 100-180nm preferably above all in a light region.

[0046] A phase contrast plate can be formed as one layer or two or more superposition layers. In the case of the phase contrast plate which consists of one layer, a smaller thing can achieve equalization of the polarization condition for every wavelength, and its wavelength dispersion of a birefringence is desirable. On the other hand, superposition-izing of a phase contrast plate is effective in amelioration of the wavelength property in a wavelength region, and the combination may be suitably determined according to a wavelength region etc.

[0047] In addition, when targetting a light region to the phase contrast plate more than two-layer, it is more desirable than the point of obtaining the light in which the layer which gives 100-180nm phase contrast is included [ of a linearly polarized light component ] as odd one or more-layer layers in many cases, like the above. Although it is more desirable than points, such as amelioration of a wavelength property, to form in the layer which gives 200-400nm phase contrast usually as for layers other than the layer which gives 100-180nm phase contrast, they are not limited to this.

[0048] A phase contrast plate can be obtained as a form birefringence sheet which comes to carry out extension processing of the film which consists of a polycarbonate, polysulfone and polyester, polymethylmethacrylate and a polyamide, poly vinyl alcohol, etc. It is so desirable that the error of the phase contrast within the field of a phase contrast layer is small, and it is more desirable than the point of maintaining luminescence reinforcement and the luminescent color to homogeneity with a large angle of visibility that the error is  $\pm 10\text{nm}$  or less above all.

[0049] The direction of the phase contrast set as a phase contrast layer or an optical axis can be suitably determined according to the oscillating direction of the linearly polarized light made into the purpose etc. In the case of the phase contrast layer which incidentally gives 135nm phase contrast, according to the sense of the circular polarization of light, the linearly polarized light (wavelength of 540nm) whose oscillating direction is +45 degrees or -45 degrees is acquired to an optical axis. In addition, when the layer which gives 100-180nm phase contrast for the exterior side surface layer especially when a phase contrast layer consists of more than two-layer occupies, it is desirable to set up an arrangement include angle based on the layer.

[0050] When the phase contrast layer as a linearly polarized light conversion means described above to the predetermined side of a circular polarization of light detached core is prepared, a polarizing plate is prepared at drawing 3 if needed on the phase contrast layer like instantiation. The polarizing plate can be used for the optical element of this gestalt as a polarizing plate by the side of the light source of a liquid crystal cell. Moreover, a polarizing plate can also be arranged, without preparing a phase contrast layer in the predetermined side of a circular polarization of light detached core. The optical element of this gestaltis [ linearly-polarized-light-] made toize the circular polarization of light which penetrated the circular polarization of light detached core through a polarizing plate, and can use it for the light source side of a liquid crystal cell

preferably.

[0051] Although a proper thing can be used as a polarizing plate, generally what consists of a polarization film is used. As an example of a polarization film, the polyene oriented film like a thing, the dehydration processing object of polyvinyl alcohol, or the demineralization acid-treatment object of a polyvinyl chloride which iodine and/or dichromatic dye were made to stick to the film of the hydrophilic giant molecule like a polyvinyl alcohol system, a partial formalized polyvinyl alcohol system, and an ethylene-vinylacetate copolymer system partial saponification object, and was extended is raised. Although the thickness of a polarization film is 5-80 micrometers usually, it is not limited to this. The polarizing plate to be used may be what covered one side or both sides of a polarization film with transparent protection layer etc.

[0052] When it is used with a light guide plate, the diffusion layer prepared in a circular polarization of light detached core if needed equalizes outgoing radiation light, controls light-and-darkness nonuniformity, and when it applies to a liquid crystal cell, it aims at prevention of the check by looking [ GIRAGIRA / check by looking ] by moire arising in interference with a pixel etc. the vertical-incidence light whose phase contrast of the diffusion layer which can be used more preferably than points, such as the maintenance nature of the polarization condition of the light which carried out outgoing radiation from the circular polarization of light detached core, is the wavelength of 633nm -- based on the incident light of less than 30 incident angles, 30nm or less is a 0-20nm thing above all preferably.

[0053] Diffusion layers are methods with arbitrary KUREIZU generating method by the method by surface irregularity-ized processing of the formation method of for example, a particle distribution resin layer, sandblasting, chemical etching, etc., mechanical stress, solvent processing, etc., imprint formation method by the metal mold which established predetermined diffusion structure, etc., and can be suitably formed as a spreading layer, a diffusion sheet, etc. to a circular polarization of light detached core, a phase contrast layer, etc. In addition, a diffusion layer can be arranged between the phase contrast layer prepared in the circular polarization of light detached core, or polarizing plates, and in the location where those top faces etc. are proper the minimum wavelength [ of a circular polarization of light detached core ], and longest wavelength side.

[0054] The polarization light equipment by this invention arranges the circular polarization of light detached core or optical element which described above the incident light from a side face to the outgoing radiation side side of the light guide plate which carries out outgoing radiation from one side of a vertical side. The example was illustrated to drawing 4 . 4 is a light guide plate. According to this polarization light equipment, the light which carried out outgoing radiation from the light guide plate carries out incidence to a circular polarization of light detached core, the circular polarization of light of one of right and left is penetrated, the circular polarization of light of another side is reflected, and re-incidence of the reflected light is carried out to a light guide plate as a return light. It is reflected in the reflex function part which consists of a reflecting layer at the bottom etc., and incidence of the light which carried out re-incidence to the light guide plate is again carried out to a circular polarization of light detached core, and it is again divided into the transmitted light and the reflected light (third-time incident light).

[0055] Therefore, although the re-incident light as the reflected light will be shut up between a circular polarization of light detached core and a light guide plate and will repeat reflection until it turns into the predetermined circular polarization of light which may penetrate a circular polarization of light detached core, in this invention, it is a small number of cycles as much as possible, and the thing of reflection of first-time re-incident light which was made to carry out



outgoing radiation repeatedly that there is nothing is more desirable [ incident light ] than points, such as use effectiveness of re-incident light, above all.

[0056] As the aforementioned light guide plate, the proper thing which carries out outgoing radiation of the incident light from a side face from one side of a vertical side can be used. A light guide plate consists of a tabular object which has the vertical side where one of usually becomes an outgoing radiation side, and the vertical face-to-face plane of incidence which consists of a 1 side-edge side at least. The light guide plate which can use preferably than the point to which the return circuit light which led the circular polarization of light which carried out re-incidence through the circular polarization of light detached core to the inferior surface of tongue, phase contrast being uninfluential and maintaining the circular polarization of light condition good, and was reflected on the inferior surface of tongue is made to come out of and put, with the circular polarization of light condition maintained is as much as possible small like the diffusion layer which the phase contrast by the birefringence in the thickness direction described above, and is a 0-20-nm thing especially 30 nm or less above all.

[0057] The structure of excelling also in the outgoing radiation effectiveness of the re-incident light which the gestalt of a light guide plate was excellent in the outgoing radiation effectiveness from an outgoing radiation side, and the outgoing radiation light was excellent in the perpendicularity to an outgoing radiation side, and was easy to use it effectively, and minded the circular polarization of light detached core, and having periodically above all prism-like irregularity more detailed than points, such as approximation nature with the direction of initial outgoing radiation of the direction of outgoing radiation, the heights which consist of a long side and a shorter side side, or a crevice is desirable (Japanese Patent Application No. No. 321036 [ seven to ]). What has the thickness of the side edge section which furthermore counters plane of incidence thinner than that of plane of incidence, and the thing which is 50% or less of thickness above all are desirable.

[0058] Thin-shape-izing of the opposite side edge section to the aforementioned plane of incidence is advantageous at the point which will carry out incidence to the shorter side side of a prism-like concave convex efficiently by the time the light which carried out incidence from plane of incidence results in the opposite side edge section concerned as a transmission edge, carries out outgoing radiation from an outgoing radiation side through the reflection, and can supply incident light to the purpose side efficiently. Moreover, -izing of the light guide plate can be carried out [ lightweight ] by considering as this thin shape-ized structure, for example, when a prism-like concave convex is a straight line-like, it can consider as about 75% of weight of the light guide plate of homogeneity thickness.

[0059] The heights or the crevice which forms the above mentioned prism-like irregularity is formed periodically usually at the repeating unit of the slant face which consists of the long side and shorter side side of the direction in alignment with plane of incidence. In addition, heights or a crevice has become [ whether the intersection (top-most vertices) of a slant face has projected rather than the straight line concerned, and ] depressed based on the straight line which connects an intersection with the datum level of the slant face which forms it (convex), or (concave) is based.

[0060] Moreover, although the long side and shorter side side of the slant face which forms heights or a crevice are judged based on the straight line which connects an intersection and top-most vertices with datum level, the thing of that of a shorter side side which the projected area to the outgoing radiation side of the long side considers as 5 or more times above all 3 or more times is more desirable than the point which raises the use effectiveness of light. It is still more

desirable to arrange so that the long side may be located in the side edge side which counters at a plane-of-incidence side in the case of heights, and counters at plane of incidence in the case of a crevice, therefore to arrange so that a long side may be located in the case of heights and a shorter side side may be located at a plane-of-incidence side in the case of a crevice.

[0061] Transmission light which carries out incidence to a long side and which carries out incidence to a shorter side side through the reflection with the above in addition to the transmission light which carries out direct incidence to a shorter side side can also be supplied to an outgoing radiation side by reflection through the shorter side side (outgoing radiation), and can aim at improvement in efficiency for light utilization. moreover, a desirable projected area [ as opposed to / a long side is a part which functions in order to carry out re-outgoing radiation of the re-incident light reflected by the circular polarization of light detached core, when it considers as polarization light equipment, and / the outgoing radiation side of a long side from this point ] -- 5 or more times of that of a shorter side side -- especially -- ten to 100 times -- it is

[0062] The configuration of the one side of a vertical side or the both sides which prepares the prism-like irregularity of a light guide plate may be determined suitably. As preferably described above, the opposite side edge section is thin-shape-ized rather than plane of incidence as an inclined plane. In that case, the configuration of an inclined plane may be determined as arbitration and can be made into a proper field configuration like a straight-line side or a curved surface. When it is not a straight-line side, it is more desirable than the point which equalizes the direction of outgoing radiation of the outgoing radiation light from an outgoing radiation side that it is in the range of less than 5 times from whenever [ average tilt-angle ] in the total location of the field in which prism-like irregularity is prepared.

[0063] The configuration of prism-like irregularity to establish does not need to be formed on a straight-line-like slant face, either, and may be formed on the slant face including a refracting interface, a curve side, etc. Moreover, neither unevenness nor its configuration of heights or a crevice needs to be the same in the whole prism-like concave convex, and its structure where the configuration and include angle change from an incidence side gradually is more desirable than the point of obtaining the outgoing radiation light which is excellent in perpendicularity.

[0064] The pitch of the heights in a prism-like concave convex or a crevice is so desirable that it is smaller than points, such as control of light-and-darkness nonuniformity, and prevention of moire with a liquid crystal cell, since outgoing radiation light is usually emitted in the shape of a stripe through the heights or crevice. 500 micrometers or less especially of 300 micrometers or less of periods of the desirable heights in consideration of manufacture precision etc. or a crevice are 5-200 micrometers above all. In addition, a period becomes more nearly deficient in productive efficiency than points, such as manufacture precision, in less than 5 micrometers, and interference and distribution by diffraction increase and it becomes unsuitable for the back light for liquid crystal displays.

[0065] Moreover, as for the above-mentioned long side in the slant face which forms heights or a crevice, it is desirable that the tilt angle to the outgoing radiation side is especially 2 or less times 5 or less times above all 0 to 10 degrees. By considering as the range of this tilt angle, based on the tilt angle of the long side concerned, it is reflected in an outgoing radiation side at a more nearly parallel include angle, and incidence is carried out to a shorter side side, it is reflected [ incidence is carried out to a long side and it is reflected, and ] in it in that case, and the light transmitted at a larger include angle than the tilt angle concerned carries out outgoing radiation from an outgoing radiation side.

[0066] The aforementioned result, -izing of the angle of incidence of the light which carries out incidence to a shorter side side can be carried out [ fixed ], the variation in angle of reflection can be controlled, and YukimitsuTaira-ization of outgoing radiation light can be achieved. Therefore, by adjusting the tilt angle concerned of the long side in the slant face which forms heights or a crevice, and a shorter side side, directivity can be given to outgoing radiation light and it becomes possible to carry out outgoing radiation of the light at a perpendicular direction thru/or the include angle near it to an outgoing radiation side by that cause.

[0067] In the light guide plate which incidentally consists of acrylic resin, the maximum angle of the light to which end-face incident light is transmitted based on the refractive index (about 1.5) is 41.8 degrees, and the maximum angle of the light to which the refractive index of a light guide plate follows on increasing, and is transmitted becomes small. Therefore, the transmission light which the rate of the transmission light which the rate of projected area to the outgoing radiation side of a long side decreases, and can control the direction of outgoing radiation through a long side if the tilt angle of said long side exceeds 10 degrees fell, and carried out incidence to the shorter side side via the long side, The variation in angle of reflection with the transmission light which carried out direct incidence to the shorter side side becomes large, and the controllability which forms outgoing radiation light into Yukimitsu Taira falls, and it becomes scarce at the directivity of outgoing radiation light. In addition, although the tilt angle of the long side concerned becomes disadvantageous for parallel-izing of outgoing radiation light at 0 times, it approves in this invention.

[0068] As for the above-mentioned shorter side side in the slant face which forms heights or a crevice on the other hand, it is desirable that the tilt angle to the outgoing radiation side is 30 degrees or more above all 25 to 50 degrees. By considering as the range of this tilt angle, the transmission light which carries out incidence through direct or a long side can be reflected in a perpendicular or the include angle near it to an outgoing radiation side through the shorter side side, and outgoing radiation of the light of a direction which acts effective in improvement in the visibility of a liquid crystal display etc. can be carried out efficiently.

[0069] About the configuration of the plane of incidence in a light guide plate, there is especially no limitation and it may be determined suitably. Generally, although it considers as a perpendicular field to an outgoing radiation side, improvement in the rate of incident light can also be stretched, for example as a configuration according to the periphery of the light sources, such as a curve concave, etc. Moreover, it can also consider as the plane-of-incidence structure of having the induction which intervenes between the light sources etc. The induction can be made into a proper configuration according to the light source etc. In addition, although the configuration of an outgoing radiation side has a common flat side etc., it can also prepare detailed prism-like irregularity if needed, and can also establish a diffusion layer. Furthermore, a circular polarization of light detached core can also be directly prepared in the outgoing radiation side of a light guide plate.

[0070] A light guide plate can be formed with the proper ingredient which shows it transparency according to the wavelength field of the light source. Incidentally what shows transparency in [ wavelength ] about 400-700nm is raised in a light region like the transparence resin represented with the acrylic resin like polymethylmethacrylate, a polycarbonate and the polycarbonate system resin like a polycarbonate polystyrene copolymer, epoxy system resin, etc., for example, glass, etc.

[0071] A light guide plate may be formed by the proper approach. As the manufacture approach more desirable than points, such as mass-production nature For example, the approach of filling

up thru/or casting and carrying out polymerization of the liquefied resin which can carry out polymerization to the mold which can form predetermined prism-like irregularity with heat, ultraviolet rays thru/or a radiation, etc., Approaches, such as injection molding with which the metal mold which can fabricate the resin made to fluidize through the approach of pushing thermoplastics against the bottom of heating to the metal mold which can form predetermined prism-like irregularity, and imprinting a configuration, the thermoplastics which carried out heating melting, or heat and a solvent in a predetermined configuration is filled up, etc. are raised.

[0072] The light guide plate does not need to be formed as a like and may be formed as layered product of dissimilar material etc. and according to one sort of ingredients one-single layer material, although the sheet for prism-like concave convex formation was pasted up on the light guide section which bears transmission of light. In the above-mentioned light guide plate, the property of the angular distribution of outgoing radiation light, field internal division cloth, etc. can be adjusted based on control of the surface ratio of a shorter side side and a long side, the configuration of a tilt angle and a prism-like concave convex, curvature, etc.

[0073] Incidentally, a refractive index is the inclined plane where a prism-like concave convex does not have curvature by 1.5, and, in the case of the light guide plate in which initial outgoing radiation light carries out outgoing radiation perpendicularly, re-outgoing radiation of the re-incident light which minded the circular polarization of light detached core by making the tilt angle to the outgoing radiation side of a long side into 6.6 or less degrees can be carried out by include-angle change of less than 10 degrees. Moreover, when a prism-like concave convex has curvature in that case, re-outgoing radiation of the re-incident light concerned can be carried out by include-angle change of less than 10 degrees by having at a rate more than the predetermined area which described above the part from which the tilt angle concerned becomes 6.6 or less degrees.

[0074] Size of a light guide plate, magnitude of the light source, etc. by the purpose of use can determine the thickness of a light guide plate suitably. Especially the general thickness of the light guide plate in the case of using for a liquid crystal display etc. is 0.5-8mm 0.1-10mm above all 20mm or less based on the plane of incidence.

[0075] the opposed face of the outgoing radiation side of a light guide plate -- like the example of drawing -- the need -- responding -- a reflecting layer 41 -- a metallic reflective layer can be arranged preferably. This reflecting layer prevents generating of the leakage light from the opposed face concerned, is effective in improvement in outgoing radiation effectiveness, and functions as a polarization conversion means of polarization light equipment. You may unite with the opposed face concerned, and a reflecting layer is piled up as a reflective sheet etc., and can take a proper arrangement gestalt in this invention.

[0076] According to the reflecting layer which consists of a metal in the above, reflex time can be made to reverse a polarization property efficiently, and the case where it is based on the total reflection and diffuse reflection the polarization conversion efficiency minded the interface of a refractive-index difference is excelled. When the circular polarization of light incidentally carries out incidence in general at right angles to a metal side, the conversion efficiency of right and left of the circular polarization of light serves as about 100% of value, and shows 90% or more of conversion efficiency even in 30 incident angles.

[0077] A metallic reflective layer more desirable than the point of polarization conversion efficiency has a metal side containing at least one sort of the metal of a high reflection factor which consists of aluminum, silver, gold, copper, or chromium. The metallic reflective layer

which is excellent in adhesion with the opposed face of the outgoing radiation side of a light guide plate can be formed as the mixing coating layer of the metal powder by binder resin, an attachment layer of the metal thin film by a vacuum evaporation method etc., etc. The metallic reflective layer may be formed as a multilayer interference thin film etc., and can also prepare the proper coat layer aiming at improvement in a reflection factor, antioxidizing, etc. in the one side or both sides if needed.

[0078] In addition, about a reflecting layer, it can replace with the aforementioned reflecting layer 41, or a reflecting plate can also be formed along with the opposed face of the outgoing radiation side of a light guide plate with the reflecting layer. The method which forms a reflecting plate in the opposed face concerned of a light guide plate has the advantage which can make small the re-outgoing radiation angle of the re-incident light through a circular polarization of light detached core, when the tilt angle of a long side is the same. About the reflecting plate, it can apply to the aforementioned reflecting layer correspondingly, and the reflecting plate which has a metallic reflection side can use preferably. Therefore, as a reflecting plate, proper things, such as a resin sheet which attached the metal thin film, and a metallic foil, a metal plate, can be used. The front face of a reflecting plate does not make it indispensable to be a mirror plane, but, on the whole, may be formed in homogeneity as two or more pages, a continuation curved surface, etc. of a small include angle.

[0079] Moreover, the thing of less than 5 times has above all the half width of the half-value width of the breadth of the angle of reflection of the reflected light at the time of carrying out incidence of the parallel light more desirable as a reflecting plate than the point which controls the breadth of re-outgoing radiation light less than 10 degrees. Therefore, as a reflecting plate, a reflection factor is high and the breadth of angle of reflection can use a small proper thing. It has a rough front face by irregularity, a reduction roll, etc., and you may make it the angle of reflection of the reflected light spread a little.

[0080] According to the above-mentioned light guide plate, various equipments, such as a liquid crystal display which can carry out outgoing radiation of the light made parallel with high precision using it in the direction which is excellent in perpendicularity advantageous to a check by looking, and can obtain the polarization light equipment which is excellent in brightness, using the light from the light source efficiently, as a result is excellent in low-power nature it is bright and legible, can be formed. In addition, as a light guide plate, a match can use [ the wavelength region of the outgoing radiation light based on it, and the wavelength region of light which a circular polarization of light detached core reflects as the circular polarization of light besides predetermined ] preferably as much as possible.

[0081] The back light of a side light mold is formed like the example of drawing by arranging the light source 42 to the plane of incidence of a light guide plate usually. Although a thing proper as the light source can be used, array objects, such as the shape of the point light source of the linear light source of a cathode-ray tube etc., light emitting diode, etc., its line, or a field, etc. can use preferably, for example (cold, heat). On the occasion of formation of the back light concerned, it can also consider as the combination object which has arranged proper auxiliary means, such as the light source holder 43 which surrounds the light source in order to lead the emission light from a linear light source to the side face of a light guide plate like the example of drawing if needed, and a prism sheet for the outgoing radiation directional control of light.

[0082] In addition, generally as a light source holder, a resin sheet, a metallic foil, etc. which attached the high reflection factor metal thin film are used. When pasting up a light source holder on the edge of a light guide plate through adhesives etc., formation of prism-like irregularity can

also be omitted about a part for the jointing. Moreover, a light source holder can be installed in the predetermined side of a light guide plate, and it can also be made to serve as a reflecting plate.

[0083] The light guide plate which can be preferably used for formation of polarization light equipment While the directivity is made to carry out outgoing radiation of the incident light from a side face from an outgoing radiation side at high effectiveness, and the outgoing radiation light excels [ directivity ] in high directivity and perpendicularity [ as opposed to an outgoing radiation side above all ] is shown Reflection repeats the re-incident light which it excelled in the re-outgoing radiation effectiveness of the re-incident light through a circular polarization of light detached core, and the directivity of the re-outgoing radiation light and an outgoing radiation include angle were as much as possible in agreement with the directivity of initial outgoing radiation light, and an outgoing radiation include angle, and minded the circular polarization of light detached core, and it is made to carry out outgoing radiation with a small reflective number of cycles above all that there is nothing.

[0084] The polarization light equipment by this invention changes the outgoing radiation light into the optical condition which contains a linearly polarized light component richly through a phase contrast layer etc. if needed, a polarizing plate is made easy to penetrate, and it prevents [ a reflective loss etc. is prevented by reusing the reflected light (re-incident light) by the circular polarization of light detached core as an outgoing radiation light by polarization conversion, ] an absorption loss, and enables it to aim at improvement in efficiency for light utilization as mentioned above. Although the quantity of the quantity of light which penetrates a polarizing plate ideally may be increased twice [ about ] with this method, it is more desirable than the point used as the light source that the linearly polarized light component which may penetrate a polarizing plate is included 70% or more above all 65% or more.

[0085] Like the above, it can be excellent in the use effectiveness of light, and the polarization light equipment by this invention is bright, and it can excel in perpendicularity, and light with little light-and-darkness nonuniformity can be offered, and it can use it for various equipments preferably as a back light system in a liquid crystal display etc. from large-area-izing etc. being easy.

[0086] The liquid crystal display 6 which used the polarization light equipment 5 by this invention for the back light system at drawing 5 was illustrated. For a lower polarizing plate and 62, a liquid crystal cell and 63 are [ 61 / an upper polarizing plate and 64 ] the diffusion plates for compensation. The lower polarizing plate 61 and the diffusion plate 64 for compensation are formed if needed.

[0087] A liquid crystal display is formed by generally assembling suitably component parts, such as a driving gear of accompanying in the liquid crystal cell and it which function as a liquid crystal shutter, a polarizing plate, a back light, and a phase contrast plate for compensation as occasion demands, etc. In this invention, except for the point using the above-mentioned polarization light equipment, there is especially no limitation and it can be formed according to the former. Especially, the liquid crystal display of a direct viewing type can be formed preferably.

[0088] Therefore, there is especially no limitation about the liquid crystal cell to be used, and a proper thing can be used. Although it is used in favor of what displays above all by carrying out incidence of the light of a polarization condition to a liquid crystal cell, for example, can use for the liquid crystal cell using a twist nematic liquid crystal or a super twist nematic liquid crystal etc. preferably, the liquid crystal and dichromatic dye of a non-twisting system can be used for

the liquid crystal cell using the liquid crystal of the guest host system distributed in liquid crystal, or a ferroelectric liquid crystal etc. There is especially no limitation also about the drive method of liquid crystal.

[0089] In addition, the liquid crystal display which used what has high degree of polarization is more desirable than especially the point of obtaining the display of the good contrast ratio by the incidence of the advanced linearly polarized light, as a polarizing plate by the side of a back light as a polarizing plate like the absorption mold linearly polarized light child of for example, an iodine system or a color system etc. On the occasion of formation of a liquid crystal display, proper optical layers, such as a diffusion plate formed, for example on the polarizing plate by the side of a check by looking, an anti glare layer, an antireflection film and a protective layer, a guard plate, or a phase contrast plate for compensation formed between a liquid crystal cell and a polarizing plate, can be arranged suitably.

[0090] The aforementioned phase contrast plate for compensation aims at compensating the wavelength dependency of a birefringence etc. and aiming at improvement in visibility etc. In this invention, it is arranged if needed between the polarizing plate by the side of a check by looking or/and a back light, and a liquid crystal cell etc. In addition, as a phase contrast plate for compensation, a proper thing can be used according to a wavelength region etc., and it may be formed as a superposition layer more than one layer or two-layer. The phase contrast plate for compensation can be obtained as an oriented film of instantiation etc. with the above-mentioned phase contrast plate for linearly polarized light conversion.

[0091] in this invention, laminating unification is carried out on the whole or partially, and the optical element thru/or components which forms the above-mentioned polarization light equipment and a liquid crystal display fixes -- having -- \*\*\*\* -- separation -- you may arrange in the easy condition. On the occasion of formation of a liquid crystal display etc., the outgoing radiation light which is excellent in perpendicularity or Yukimitsu Taira nature is supplied, the re-incident light through a circular polarization of light detached core is also in a condition with little the loss and include-angle change by dispersion etc., and the consistency of the direction of initial outgoing radiation light improves re-outgoing radiation, and the polarization light equipment which supplies efficiently the outgoing radiation light of a direction effective in improvement in visibility can use preferably.



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MEANS

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[Means for Solving the Problem] The outgoing radiation side side of the circular polarization of light detached core characterized by this invention superimposing two or more cholesteric-liquid-crystal layers from which reflected wave length differs based on the main wavelength of the reflected light as the sequence of merits and demerits, and the light guide plate which carries out outgoing radiation of the incident light from a side face from one side of a vertical side is provided with the polarization light equipment characterized by having the circular polarization of light detached core concerned.

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## EXAMPLE

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### [Example]

It heated after membrane formation (3 micrometers in thickness) by the spin coat method, and the glass transition temperature which has the principal chain of example of reference 1 acrylic heated the side-chain mold cholesteric-liquid-crystal polymer which is 57 degrees C for 2 minutes at 120 more degrees C after heating for 30 seconds by 140 degrees C to the polyimide rubbing processing side of a triacetyl cellulose film with a thickness of 10 micrometers, and quenched it to it, and the circular polarization of light division plate of the blue system which presents a mirror plane-like selective reflection condition was obtained. The main wavelength of selective reflection was 450nm, and this was what penetrates the left-handed circularly-polarized light.

[0093] It heated after membrane formation (3 micrometers in thickness) by the spin coat method, and the glass transition temperature which has the principal chain of example of reference 2 acrylic heated the side-chain mold cholesteric-liquid-crystal polymer which is 64 degrees C for 2 minutes at 130 more degrees C after heating for 30 seconds by 150 degrees C to the polyimide rubbing processing side of a triacetyl cellulose film with a thickness of 10 micrometers, and quenched it to it, and the circular polarization of light division plate of the green system which presents a mirror plane-like selective reflection condition was obtained. The main wavelength of selective reflection was 550nm, and this was what penetrates the left-handed circularly-polarized light.

[0094] It heated after membrane formation (3 micrometers in thickness) by the spin coat method, and the glass transition temperature which has the principal chain of example of reference 3 acrylic heated the side-chain mold cholesteric-liquid-crystal polymer which is 75 degrees C for 2 minutes at 145 more degrees C after heating for 30 seconds by 170 degrees C to the polyimide rubbing processing side of a triacetyl cellulose film with a thickness of 10 micrometers, and quenched it to it, and the reddish circular polarization of light division plate which presents a mirror plane-like selective reflection condition was obtained. The main wavelength of selective reflection was 650nm, and this was what penetrates the left-handed circularly-polarized light.

[0095] The adhesion laminating of the circular polarization of light division plate obtained in the example 1 of example 1 reference, the example 2 of reference, and the example 3 of reference was carried out in a blue system, a green system, and reddish sequence, and the circular polarization of light division plate of a superposition mold was obtained, it has arranged so that it may become a left-handed-circularly-polarized-light plate about a polarizing plate through a broadband quarter-wave length plate on the reddish circular polarization of light division plate, and the optical element was obtained.

[0096] Example of comparison 11 / 4 wavelength plate and the polarizing plate have been arranged to the circular polarization of light division-plate side of a blue system, and also the optical element was obtained according to the example 1.

[0097] The quarter-wave length plate and the polarizing plate have been arranged to the green system side, and also location sequence of an example of comparison 2 circular-polarization-of-light division plate was made into reddish, the blue system, and the green system, and the optical element was obtained according to the example 1.

[0098] The quarter-wave length plate and the polarizing plate have been arranged to the blue system side, and also location sequence of an example of comparison 3 circular-polarization-of-

light division plate was made into a green system, reddish, and a blue system, and the optical element was obtained according to the example 1.

[0099] The quarter-wave length plate and the polarizing plate have been arranged to the reddish side, and also location sequence of an example of comparison 4 circular-polarization-of-light division plate was made a green system and blue system and reddish, and the optical element was obtained according to the example 1.

[0100] The quarter-wave length plate and the polarizing plate have been arranged to the green system side, and also location sequence of an example of comparison 5 circular-polarization-of-light division plate was made into a blue system, reddish, and a green system, and the optical element was obtained according to the example 1.

[0101] The polarizing plate side was turned up, the optical element obtained in the evaluation trial example and the example of a comparison has been arranged on the surface light source of uniform brightness, the chromaticity change by change of a viewing angle was measured, and law estimated five points. Five points mean that there are few viewing-angle dependencies, therefore the small thing of the color change by the viewing angle.

[0102] The aforementioned result was shown in degree table.

実施例 1	比較例 1	比較例 2	比較例 3	比較例 4	比較例 5
5	3	1	2	1	4

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## DESCRIPTION OF DRAWINGS

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### [Brief Description of the Drawings]

[Drawing 1] The sectional view of the example of a circular polarization of light detached core

[Drawing 2] The sectional view of the example of an optical element

[Drawing 3] The sectional view of other examples of an optical element

[Drawing 4] The sectional view of the example of polarization light equipment

[Drawing 5] The sectional view of the example of a liquid crystal display

### [Description of Notations]

1: Circular polarization of light detached core

11, 13, 15: Cholesteric-liquid-crystal layer

12, 14, 16: Support base material

2: Phase contrast layer 3: Polarizing plate

5: Polarization light equipment

4: Light guide plate 41: Reflecting layer 42: Light source

6: Liquid crystal display

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## EFFECT OF THE INVENTION

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[Effect of the Invention] By the above-mentioned configuration which superimposed two or more cholesteric-liquid-crystal layers as the sequence of the merits and demerits of reflected wave length, a circular polarization of light detached core with a small color change of the outgoing radiation light by viewing-angle change can be obtained, and the polarization light equipment which is excellent in efficiency for light utilization using it, as a result the liquid crystal display which is bright and is excellent in visibility can be obtained. Although the reason outgoing radiation light carries out color change by viewing-angle change may be for penetrating a circular polarization of light detached core as polarization, the reason the color change by viewing-angle change is controlled by the aforementioned superposition method not certain therefore is unknown.

[0009]

[Embodiment of the Invention] The circular polarization of light detached core of this invention superimposes two or more cholesteric-liquid-crystal layers from which reflected wave length differs based on the main wavelength of the reflected light as the sequence of merits and demerits. The example was shown in drawing 1. 1 is a circular polarization of light detached core, and 12, 14 and 16 are [ 11, 13, and 15 ] support base materials.

[0010] As a cholesteric-liquid-crystal layer, the proper thing which divides the natural light into the circular polarization of light on either side as the transmitted light and the reflected light by GURANJAN orientation can be used. Incidentally as the example, the sheet which has the layer which has a cholesteric-liquid-crystal phase, and the layer which consists of a liquid crystal polymer which presents a cholesteric phase above all, the sheet which developed the layer concerned on the glass plate etc., or the film which consists of a liquid crystal polymer which presents a cholesteric phase is raised.

[0011] As for a cholesteric-liquid-crystal layer, in the above, it is desirable to carry out orientation to homogeneity as much as possible. The cholesteric-liquid-crystal layer of homogeneity orientation offers the reflected light without dispersion, is advantageous to expansion of the angle of visibility of a liquid crystal display etc., and suitable for formation of the direct viewing type liquid crystal display by which direct observation is especially carried out also from across.

[0012] The circular polarization of light detached core by this invention can form two or more cholesteric-liquid-crystal layers from which reflected wave length differs by superimposing two-layer or three layers or more as the sequence of merits and demerits based on the main wavelength of the reflected light. Superposition-ization of this cholesteric-liquid-crystal layer is aimed at extensive wavelength region-ization of isolation.

[0013] Namely, although a limitation is located in the wavelength region which shows selective-reflection nature (circular dichroism) and the limitation also has usually the case of the large range which reaches about 100nm wavelength region in the cholesteric-liquid-crystal layer of a monolayer, since it is less than the whole region of the light desired when applying to a liquid crystal display etc. also in the wavelength range, it aims at making the wavelength region which is made to superimpose the cholesteric-liquid-crystal layer from which selective-reflection nature (reflected wave length) differs, and shows circular dichroism expand in such a case.

[0014] It is the combination which reflects the circular polarization of light of the same direction,

and the cholesteric-liquid-crystal layer which is incidentally in the range whose main wavelength of selective reflection is 300-900nm can be used in the combination from which the main wavelength of selective reflection differs, and combination which is different 30-200nm above all, respectively, and the circular polarization of light detached core which can cover the wavelength region where a light region etc. is large by superimposing the 2-6 kinds can be formed efficiently. Especially as an object for the lights, that on which reflected wave length superimposed three sorts of cholesteric-liquid-crystal layers, a blue network, a green network, and a red network, is more desirable than points, such as thin-shape-izing by the small number of superposition.

[0015] It aims at increase in quantity of the polarization in the condition that it can prevent and use that the point used as a superposition object in the combination of what reflect the circular polarization of light of the same above mentioned polarization direction will be in a polarization condition which arranges the phase condition of the circular polarization of light reflected on each class, and is different in each wavelength region.

[0016] A proper thing may be used for the cholesteric liquid crystal which forms a circular polarization of light detached core, and there is especially no limitation in it. Therefore, various things, such as a principal chain mold with which the straight-line-like atomic group (meso gene) of the conjugate property which gives a liquid crystal stacking tendency was introduced into the principal chain and side chain of a polymer, and a side-chain mold, can be used. The wavelength region of selective reflection becomes large and the larger cholesteric-liquid-crystal molecule of phase contrast can be used more preferably than points, such as allowances over mitigation of a number of layers, or the wavelength shift at the time of a large angle of visibility. Moreover, rather than weight or the point of \*\*\*\*\*, a liquid crystal polymer can use preferably. Furthermore, as the liquid crystal polymer, that whose glass transition temperature is 30-150 degrees C can use preferably from points, such as handling nature and the stability of the orientation in operating temperature.

[0017] Incidentally, as an example of the liquid crystal polymer of the above mentioned principal chain mold, it has the structure which combined the meso gene radical which minds the spacer section which gives flexibility if needed, and consists of a Para permutation ring compound etc., for example, polymers, such as a polyester system, a polyamide system, a polycarbonate system, and a polyester imide system, are raised.

[0018] Moreover, a thing, a nematic system liquid crystal polymer of low-molecular chiral agent content, a liquid crystal polymer of chiral component installation, a mixed liquid crystal polymer of a nematic system and a cholesteric system, etc. which have the low-molecular-liquid-crystal compound (meso gene section) which makes polyacrylate, polymethacrylate, a polysiloxane, poly malonate, etc. a principal chain frame, minds the spacer section which consists of an atomic group of conjugate property as a side chain as an example of the liquid crystal polymer of a side-chain mold if needed, and consists of a Para permutation ring compound etc. are raised.

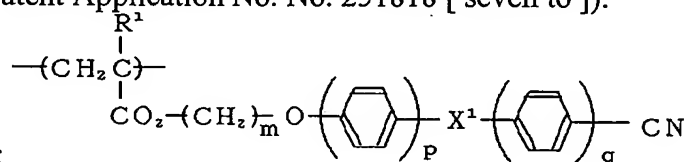
[0019] Like the above, it can consider as the thing of a cholesteric stacking tendency with the method which introduces the proper chiral component which consists of a compound which has asymmetrical carbon also in what has the Para permutation ring compound which gives the nematic stacking tendency which consists of the Para permutation aromatic-series unit, the Para permutation cyclohexyl ring unit, etc. like for example, an azomethine form, an azo form, an AZOKISHI form and an ester form, a biphenyl form and a phenylcyclohexane form, and a bicyclo hexane form, a low-molecular chiral agent, etc. (JP,55-21479,A, U.S. Pat. No. 5332522, etc.). In addition, a cyano group, the alkyl group, alkoxy group of the end substituent in the para

position in the Para permutation ring compound, etc. may be proper.

[0020] Moreover, as the spacer section, for example, polymethylene chain-(CH<sub>2</sub>)<sub>n</sub>-, polyoxymethylene chain-(CH<sub>2</sub>CH<sub>2</sub>O)<sub>m</sub>-, etc. which show flexibility are raised. the chemical structure of the meso gene section etc. determines suitably the number of cycles of the structural unit which forms the spacer section -- having -- general -- the case of a polymethylene chain -- n -- 0-20, and the case where they are 2-12, and a polyoxymethylene chain above all -- m -- 0-10 -- it is 1-3 above all.

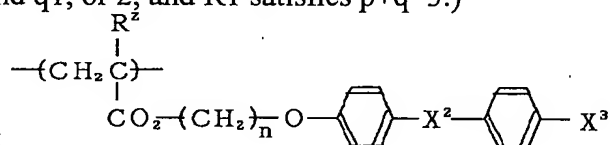
[0021] In addition, the proper method according to the usual polymer composition to which copolymerization for example, of the component monomer is carried out with a radical polymerization method, a cationic polymerization method, an anionic polymerization method, etc. can perform preparation of the above-mentioned principal chain mold liquid crystal polymer. Moreover, the monomer addition polymerization method which polymer-izes the monomer to which preparation of a side-chain mold liquid crystal polymer also introduced the meso gene radical into the monomer for vinyl system principal chain formation like the ester of an acrylic acid or a methacrylic acid through the spacer radical if needed by a radical polymerization method etc., The method which carries out the addition reaction of the vinyl permutation meso gene monomer to the bottom of existence of a platinum system catalyst through Si-H association of polyoxy methyl silylene, The method which introduces a meso gene radical by the esterification reaction using a correlation migration catalyst through the functional group given to the principal chain polymer, A method with the proper method which carries out a polycondensation reaction can perform the monomer which introduced the meso gene radical into some malonic acids through the spacer radical if needed, and diol.

[0022] In the above Membrane formation nature and the good GURANJAN stacking tendency of a mono-domain condition, The short-time nature of orientation processing, the stable stability to a vitreous state, the controllability of the spiral pitch of a cholesteric phase, The liquid crystal polymer which can be used more preferably than points, such as the plasticity of the circular polarization of light detached core which orientation conditions, such as a pitch, cannot change easily due to operating temperature, and is lightly [ it is thin and ] excellent in endurance or preservation stability the copolymer which uses as a component the monomeric unit expressed with the following general formula (a), and the monomeric unit expressed with a general formula (b) -- above all with 60 - 95 % of the weight of monomeric units of a general formula (a) Let the copolymer which consists of 40 - 5 % of the weight of monomeric units of a general formula (b) be a component (Japanese Patent Application No. No. 251818 [ seven to ]).



[0023] General formula (a) :

(However, the integer of 1-6 and X1 are two COs or an OCO radical, and hydrogen or a methyl group, and m are p and q1, or 2, and R1 satisfies p+q=3.)

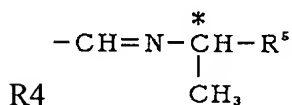
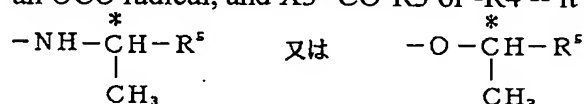


General formula (b) :

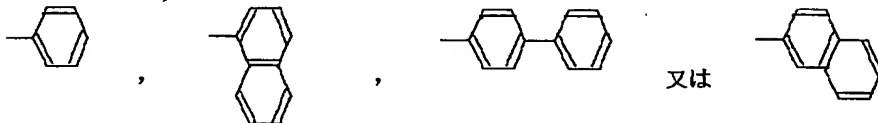
R2 [ however, ] -- hydrogen or a methyl group, and n -- the integer of 1-6, and X2 -- two COs or



an OCO radical, and X3 -CO-R3 or -R4 -- it is -- the R3



It comes out, and it is and R5 is as follows.



[0024] The acrylic monomer which can form the monomeric unit expressed with the aforementioned general formula (a) and a general formula (b) is compoundable by the proper approach. As the example, first ethylene chlorohydrin and 4-hydroxybenzoic acid After carrying out heating reflux in an alkali water solution by making potassium iodide into a catalyst and obtaining hydroxycarboxylic acid, Carry out dehydration of it to an acrylic acid or a methacrylic acid, and it considers as acrylate (meta). By esterifying the (meta) acrylate under existence of DCC (dicyclohexylcarbodiimide) and DMAP (dimethylamino pyridine) by the 4-cyano-4'-hydroxy biphenyl, the method of obtaining the monomer belonging to a general formula (a) raises, and it is \*\*\*\*.

[0025] moreover, as a synthetic example of the acrylic monomer belonging to a general formula (b) After carrying out the heating reflux of hydroxyalkyl halide and the 4-hydroxybenzoic acid in an alkali water solution by making potassium iodide into a catalyst first and obtaining hydroxycarboxylic acid, Dehydration of it is carried out to an acrylic acid or a methacrylic acid. As acrylate (meta) the acrylate (meta) of *Perilla frutescens* (L.) Britton var. *crispa* (Thunb.) Decne. The approach of esterifying under existence of DCC and DMAP, the approach of esterifying the (meta) acrylate under existence of DCC and DMAP after the aforementioned dehydration with the phenol which has an asymmetrical carbon radical in the 4th place, etc. are raised with the phenol which has CO radical of R three-set content in the 4th place.

[0026] Therefore, other monomers belonging to an aforementioned general formula (a) and an aforementioned general formula (b) are compoundable according to the above using the proper raw material which has the introductory target radical. In addition, the phenol which has CO radical of R three-set content in the 4th aforementioned place For example, make methyl chloroformate and 4-hydroxybenzoic acid react in an alkali water solution first, and it considers as a carboxylic acid. After making it into acid chloride by oxalyl chloride, by the approach of making it reacting with H-R3 in a pyridine/tetrahydrofuran, introducing R3 set, processing it with aqueous ammonia subsequently, and removing a protective group etc. Moreover, the phenol which has an asymmetrical carbon radical in the 4th place can be obtained by the approach of carrying out azeotropy dehydration of for example, a 4-hydroxy benzaldehyde and the (S)-(-)-1-phenyl ethylamine in toluene etc.

[0027] The above-mentioned copolymer can change the spiral pitch of cholesteric liquid crystal by changing the content of the monomeric unit expressed with the general formula (b). Therefore, the wavelength which shows circular dichroism by control of the content of the monomeric unit expressed with a general formula (b) can be adjusted, and the optical element

which shows circular dichroism to the light of a light region can also be obtained easily.

[0028] Formation of the cholesteric-liquid-crystal layer by the liquid crystal polymer can be performed by the approach according to the conventional orientation processing. Incidentally as the example, on a support base material, polyimide and polyvinyl alcohol, The orientation film which formed film, such as polyester, polyarylate and polyamidoimide, and polyether imide, and carried out rubbing processing with the rayon cloth etc., A liquid crystal polymer is developed on the proper orientation film which consists of a method vacuum evaporation layer of slanting of SiO<sub>2</sub>, or orientation film by extension processing. Or more than glass transition temperature It heats under to isotropic phase transition temperature, after the liquid crystal polymer molecule has carried out GURANJAN orientation, it cools under to glass transition temperature, and it considers as a vitreous state, and the approach of forming the flozen layer by which the orientation concerned was fixed etc. is raised.

[0029] As the aforementioned support base material, proper things, such as a monolayer which consists of plastics like triacetyl cellulose, polyvinyl alcohol and polyimide, polyarylate and polyester, a polycarbonate, polysulfone and polyether sulphone, amorphous polyolefine and a denaturation acrylic polymer, and epoxy system resin, for example, a laminated film, or a glass plate, can be used. Plastic film is more desirable than points, such as thin-shape-izing, and a small thing has the phase contrast as much as possible more desirable than points, such as improvement in the use effectiveness of the light by prevention of change of a polarization condition, by the birefringence.

[0030] Expansion of a liquid crystal polymer can carry out thin layer expansion of the solution by the solvent of a liquid crystal polymer by proper approaches, such as a spin coat method, the roll coat method, the flow coat method and the printing method, a dip coating method and the flow casting forming-membranes method, the bar coat method, and gravure, and can be performed by the approach of carrying out desiccation processing of it if needed etc. As the aforementioned solvent, proper things, such as a methylene chloride, a cyclohexanone and a trichloroethylene, tetrachloroethane and N-methyl pyrrolidone, and a tetrahydrofuran, can be used, for example.

[0031] Moreover, the heating melt of a liquid crystal polymer and the heating melt in the condition of presenting an isotropic phase preferably can be developed according to the above, and the approach which does not use solvents, such as an approach which develops to a thin layer and it is made to solidify further, maintaining the melting temperature if needed, therefore the health nature of work environment, etc. can develop a liquid crystal polymer also by the good approach. In addition, on the occasion of expansion of a liquid crystal polymer, the superposition method of the cholesteric-liquid-crystal layer which minded the orientation film if needed for the purpose of thin-shape-izing etc. can be taken.

[0032] Heat-treatment for carrying out orientation of the expansion layer of a liquid crystal polymer can be performed by heating to the temperature requirement from the glass transition temperature of a liquid crystal polymer to isotropic phase transition temperature, i.e., the temperature requirement where a liquid crystal polymer presents a liquid crystal phase, as described above. Moreover, immobilization of an orientation condition can be performed by cooling under to glass transition temperature, and there is especially no limitation about the cooling condition. Usually, since the aforementioned heat-treatment can be performed at the temperature of 300 degrees C or less, generally a natural-air-cooling method is taken.

[0033] The flozen layer of the liquid crystal polymer formed on the support base material can be used for a circular polarization of light detached core as it is as an one object with a support base

material, and can also be used as a circular polarization of light detached core which exfoliates from Japanese lacquer and a support base material, and consists of a film etc. When forming as an one object with the support base material which consists of a film etc., it is more desirable than points, such as the tightness of the change of state of polarization, that phase contrast uses a small support base material as much as possible.

[0034] Especially the thickness of a cholesteric-liquid-crystal layer has 2-10 micrometers more desirable than points, such as a size of turbulence of orientation, prevention of a permeability fall, and the wavelength range of selective reflection, 1-30 micrometers above all 0.5-50 micrometers. Moreover, it is more desirable than points, such as thin-shape-izing of a circular polarization of light detached core, that 2-50 micrometers of 3-30 micrometers of total thickness of each cholesteric-liquid-crystal layer are 5-10 micrometers especially above all. When it furthermore has a support base material, it is desirable that 20-200 micrometers of 25-150 micrometers of total thickness including the base material are 30-100 micrometers especially above all. On the occasion of formation of a circular polarization of light detached core, the various additives which become a cholesteric-liquid-crystal layer from a stabilizer, a plasticizer, or metals can be blended if needed.

[0035] The circular polarization of light detached core used in this invention can be made into a gestalt with proper cel gestalt which pinched the cholesteric-liquid-crystal layer which consists for example, of a low-molecular-weight object with transparence base materials, such as glass and a film, gestalt which supported the cholesteric-liquid-crystal layer which consists of a liquid crystal polymer with the transparence base material, gestalt which consists of a film of the liquid crystal polymer of a cholesteric-liquid-crystal layer, gestalt which superimposed those gestalt objects in proper combination.

[0036] In the aforementioned case, a cholesteric-liquid-crystal layer can also be held according to the reinforcement, operability, etc. with the support base material more than one layer or two-layer. the point of preventing the change of state of polarization in using the support base material more than two-layer etc. -- for example, the film of non-orientation -- even if it carries out orientation, a small thing can use [ phase contrast ] preferably as much as possible like the small triacetate film of a birefringence etc. Gestalten more desirable than points, such as thin-shape-izing, are the gestalt supported with the transparence base material, a gestalt which consists of a film of a liquid crystal polymer.

[0037] In addition, as for each class of superposition, being formed as a flat layer is more desirable than the point that a circular polarization of light detached core copes with equalization of the above-mentioned separability ability, and the wavelength shift of oblique-incidence light etc. Use of a liquid crystal polymer is more advantageous to especially superposition of a cholesteric-liquid-crystal layer than points, such as manufacture effectiveness and thin-film-izing. Superposition processing can take proper methods, such as every mere pile and adhesion through adhesives, such as a binder.

[0038] In this invention, one sort of proper optical layers, such as a phase contrast layer, a polarizing plate, and a diffusion layer, or two sorts or more can be arranged, and various optical elements can be formed in the cholesteric-liquid-crystal layer side of the longest wavelength which becomes the optical outgoing radiation side of a circular polarization of light detached core. The example was shown in drawing 2 and drawing 3. 2 is a phase contrast layer and 3 is a polarizing plate.

[0039] A phase contrast layer functions as a linearly polarized light conversion means, the circular polarization of light which carried out outgoing radiation from the circular polarization

of light detached core carries out incidence to a phase contrast layer, a phase change is received, the light of the wavelength on which the phase change is equivalent to quarter-wave length is changed into the linearly polarized light, and other wavelength light is changed into elliptically polarized light. The changed elliptically polarized light turns into such flat elliptically polarized light that it is close to the wavelength of the light changed into the aforementioned linearly polarized light. Outgoing radiation of the light in the condition that many linearly polarized light components which may penetrate a polarizing plate are included will be carried out as a result of [ this ] a phase contrast layer.

[0040] By changing into a condition with many linearly polarized light components, it can consider as the light which is easy to penetrate a polarizing plate. In the case of a liquid crystal display, this polarizing plate functions as the optical layer which prevents the fall of the polarization property generated in change of the angle of visibility to a liquid crystal cell, and maintains display grace, an optical layer which realizes more advanced degree of polarization and attains better display grace.

[0041] That is, in the above, although it is possible to carry out incidence of the outgoing radiation polarization [ detached core / circular polarization of light ] to a liquid crystal cell as it is, and to attain a display, without using a polarizing plate, since improvement in the display grace described above by minding a polarizing plate etc. can be aimed at, a polarizing plate may be used if needed. In that case, it is so more advantageous that the permeability to a polarizing plate is high than the point of the brightness of a display, and since the permeability becomes so high that many linearly polarized light components of the polarization direction which is in agreement with the polarization shaft (transparency shaft) of a polarizing plate are included, outgoing radiation polarization [ detached core / circular polarization of light ] is changed into the predetermined linearly polarized light through a linearly polarized light conversion means for the purpose of it.

[0042] The liquid crystal display which can obtain the permeability which exceeds 80% when a polarization shaft is made in agreement and incidence of the linearly polarized light is carried out, therefore whose use effectiveness of light improves sharply, and is incidentally excellent in brightness although the permeability is about 43% when incidence of the natural light or the circular polarization of light is carried out to a usual iodine system polarizing plate becomes possible. Moreover, in this polarizing plate, the degree of polarization which reaches to 99.99% can also be attained. If independent, this achievement of high degree of polarization is difficult, and the degree of polarization especially to the incident light from slant which is a circular polarization of light detached core tends to fall.

[0043] While it is equivalent to the phase contrast of quarter-wave length in the circular polarization of light which carried out outgoing radiation and being able to form many linearly polarized lights from a circular polarization of light detached core as a phase contrast layer, what can change the light of other wavelength into the flat elliptically polarized light near the linearly polarized light as much as possible [ have the major-axis direction in the parallel direction as much as possible with said linearly polarized light, and ] is desirable. A phase contrast layer can also be prepared [ polarizing plate ] in one with a circular polarization of light detached core.

[0044] By using the phase contrast layer like the above, it can arrange so that the direction of the linearly polarized light of the outgoing radiation light and the major-axis direction of elliptically polarized light may become parallel as much as possible with the transparency shaft of a polarizing plate, and the light of a condition with many linearly polarized light components which may penetrate a polarizing plate can be obtained. A phase contrast layer can be formed

with the proper quality of the material, what gives transparent and uniform phase contrast is desirable, and, generally a phase contrast plate is used.

[0045] The phase contrast given in a phase contrast layer can be suitably determined according to the wavelength region of the circular polarization of light by which outgoing radiation is carried out etc. from a circular polarization of light detached core. Incidentally, from points, such as wavelength range and conversion efficiency, it also considers that it is that almost all the phase contrast plate indicates the wavelength dispersion of a forward birefringence to be from the quality-of-the-material property, and a thing with the small phase contrast and the thing which gives phase contrast 110-150nm or less especially can use 100-180nm preferably above all in a light region.

[0046] A phase contrast plate can be formed as one layer or two or more superposition layers. In the case of the phase contrast plate which consists of one layer, a smaller thing can achieve equalization of the polarization condition for every wavelength, and its wavelength dispersion of a birefringence is desirable. On the other hand, superposition-izing of a phase contrast plate is effective in amelioration of the wavelength property in a wavelength region, and the combination may be suitably determined according to a wavelength region etc.

[0047] In addition, when targetting a light region to the phase contrast plate more than two-layer, it is more desirable than the point of obtaining the light in which the layer which gives 100-180nm phase contrast is included [ of a linearly polarized light component ] as odd one or more-layer layers in many cases, like the above. Although it is more desirable than points, such as amelioration of a wavelength property, to form in the layer which gives 200-400nm phase contrast usually as for layers other than the layer which gives 100-180nm phase contrast, they are not limited to this.

[0048] A phase contrast plate can be obtained as a form birefringence sheet which comes to carry out extension processing of the film which consists of a polycarbonate, polysulfone and polyester, polymethylmethacrylate and a polyamide, poly vinyl alcohol, etc. It is so desirable that the error of the phase contrast within the field of a phase contrast layer is small, and it is more desirable than the point of maintaining luminescence reinforcement and the luminescent color to homogeneity with a large angle of visibility that the error is  $\pm 10\text{nm}$  or less above all.

[0049] The direction of the phase contrast set as a phase contrast layer or an optical axis can be suitably determined according to the oscillating direction of the linearly polarized light made into the purpose etc. In the case of the phase contrast layer which incidentally gives 135nm phase contrast, according to the sense of the circular polarization of light, the linearly polarized light (wavelength of 540nm) whose oscillating direction is +45 degrees or -45 degrees is acquired to an optical axis. In addition, when the layer which gives 100-180nm phase contrast for the exterior side surface layer especially when a phase contrast layer consists of more than two-layer occupies, it is desirable to set up an arrangement include angle based on the layer.

[0050] When the phase contrast layer as a linearly polarized light conversion means described above to the predetermined side of a circular polarization of light detached core is prepared, a polarizing plate is prepared at drawing 3 if needed on the phase contrast layer like instantiation. The polarizing plate can be used for the optical element of this gestalt as a polarizing plate by the side of the light source of a liquid crystal cell. Moreover, a polarizing plate can also be arranged, without preparing a phase contrast layer in the predetermined side of a circular polarization of light detached core. The optical element of this gestaltis [ linearly-polarized-light-] made toize the circular polarization of light which penetrated the circular polarization of light detached core through a polarizing plate, and can use it for the light source side of a liquid crystal cell

preferably.

[0051] Although a proper thing can be used as a polarizing plate, generally what consists of a polarization film is used. As an example of a polarization film, the polyene oriented film like a thing, the dehydration processing object of polyvinyl alcohol, or the demineralization acid-treatment object of a polyvinyl chloride which iodine and/or dichromatic dye were made to stick to the film of the hydrophilic giant molecule like a polyvinyl alcohol system, a partial formalized polyvinyl alcohol system, and an ethylene-vinylacetate copolymer system partial saponification object, and was extended is raised. Although the thickness of a polarization film is 5-80 micrometers usually, it is not limited to this. The polarizing plate to be used may be what covered one side or both sides of a polarization film with transparent protection layer etc.

[0052] When it is used with a light guide plate, the diffusion layer prepared in a circular polarization of light detached core if needed equalizes outgoing radiation light, controls light-and-darkness nonuniformity, and when it applies to a liquid crystal cell, it aims at prevention of the check by looking [ GIRAGIRA / check by looking ] by moire arising in interference with a pixel etc. the vertical-incidence light whose phase contrast of the diffusion layer which can be used more preferably than points, such as the maintenance nature of the polarization condition of the light which carried out outgoing radiation from the circular polarization of light detached core, is the wavelength of 633nm -- based on the incident light of less than 30 incident angles, 30nm or less is a 0-20nm thing above all preferably.

[0053] Diffusion layers are methods with arbitrary KUREIZU generating method by the method by surface irregularity-ized processing of the formation method of for example, a particle distribution resin layer, sandblasting, chemical etching, etc., mechanical stress, solvent processing, etc., imprint formation method by the metal mold which established predetermined diffusion structure, etc., and can be suitably formed as a spreading layer, a diffusion sheet, etc. to a circular polarization of light detached core, a phase contrast layer, etc. In addition, a diffusion layer can be arranged between the phase contrast layer prepared in the circular polarization of light detached core, or polarizing plates, and in the location where those top faces etc. are proper the minimum wavelength [ of a circular polarization of light detached core ], and longest wavelength side.

[0054] The polarization light equipment by this invention arranges the circular polarization of light detached core or optical element which described above the incident light from a side face to the outgoing radiation side side of the light guide plate which carries out outgoing radiation from one side of a vertical side. The example was illustrated to drawing 4 . 4 is a light guide plate. According to this polarization light equipment, the light which carried out outgoing radiation from the light guide plate carries out incidence to a circular polarization of light detached core, the circular polarization of light of one of right and left is penetrated, the circular polarization of light of another side is reflected, and re-incidence of the reflected light is carried out to a light guide plate as a return light. It is reflected in the reflex function part which consists of a reflecting layer at the bottom etc., and incidence of the light which carried out re-incidence to the light guide plate is again carried out to a circular polarization of light detached core, and it is again divided into the transmitted light and the reflected light (third-time incident light).

[0055] Therefore, although the re-incident light as the reflected light will be shut up between a circular polarization of light detached core and a light guide plate and will repeat reflection until it turns into the predetermined circular polarization of light which may penetrate a circular polarization of light detached core, in this invention, it is a small number of cycles as much as possible, and the thing of reflection of first-time re-incident light which was made to carry out

outgoing radiation repeatedly that there is nothing is more desirable [ incident light ] than points, such as use effectiveness of re-incident light, above all.

[0056] As the aforementioned light guide plate, the proper thing which carries out outgoing radiation of the incident light from a side face from one side of a vertical side can be used. A light guide plate consists of a tabular object which has the vertical side where one of usually becomes an outgoing radiation side, and the vertical face-to-face plane of incidence which consists of a 1 side-edge side at least. The light guide plate which can use preferably than the point to which the return circuit light which led the circular polarization of light which carried out re-incidence through the circular polarization of light detached core to the inferior surface of tongue, phase contrast being uninfluential and maintaining the circular polarization of light condition good, and was reflected on the inferior surface of tongue is made to come out of and put, with the circular polarization of light condition maintained is as much as possible small like the diffusion layer which the phase contrast by the birefringence in the thickness direction described above, and is a 0-20-nm thing especially 30 nm or less above all.

[0057] The structure of excelling also in the outgoing radiation effectiveness of the re-incident light which the gestalt of a light guide plate was excellent in the outgoing radiation effectiveness from an outgoing radiation side, and the outgoing radiation light was excellent in the perpendicularity to an outgoing radiation side, and was easy to use it effectively, and minded the circular polarization of light detached core, and having periodically above all prism-like irregularity more detailed than points, such as approximation nature with the direction of initial outgoing radiation of the direction of outgoing radiation, the heights which consist of a long side and a shorter side side, or a crevice is desirable (Japanese Patent Application No. No. 321036 [ seven to ]). What has the thickness of the side edge section which furthermore counters plane of incidence thinner than that of plane of incidence, and the thing which is 50% or less of thickness above all are desirable.

[0058] Thin-shape-izing of the opposite side edge section to the aforementioned plane of incidence is advantageous at the point which will carry out incidence to the shorter side side of a prism-like concave convex efficiently by the time the light which carried out incidence from plane of incidence results in the opposite side edge section concerned as a transmission edge, carries out outgoing radiation from an outgoing radiation side through the reflection, and can supply incident light to the purpose side efficiently. Moreover, -izing of the light guide plate can be carried out [ lightweight ] by considering as this thin shape-ized structure, for example, when a prism-like concave convex is a straight line-like, it can consider as about 75% of weight of the light guide plate of homogeneity thickness.

[0059] The heights or the crevice which forms the above mentioned prism-like irregularity is formed periodically usually at the repeating unit of the slant face which consists of the long side and shorter side side of the direction in alignment with plane of incidence. In addition, heights or a crevice has become [ whether the intersection (top-most vertices) of a slant face has projected rather than the straight line concerned, and ] depressed based on the straight line which connects an intersection with the datum level of the slant face which forms it (convex), or (concave) is based.

[0060] Moreover, although the long side and shorter side side of the slant face which forms heights or a crevice are judged based on the straight line which connects an intersection and top-most vertices with datum level, the thing of that of a shorter side side which the projected area to the outgoing radiation side of the long side considers as 5 or more times above all 3 or more times is more desirable than the point which raises the use effectiveness of light. It is still more



desirable to arrange so that the long side may be located in the side edge side which counters at a plane-of-incidence side in the case of heights, and counters at plane of incidence in the case of a crevice, therefore to arrange so that a long side may be located in the case of heights and a shorter side side may be located at a plane-of-incidence side in the case of a crevice.

[0061] Transmission light which carries out incidence to a long side and which carries out incidence to a shorter side side through the reflection with the above in addition to the transmission light which carries out direct incidence to a shorter side side can also be supplied to an outgoing radiation side by reflection through the shorter side side (outgoing radiation), and can aim at improvement in efficiency for light utilization. moreover, a desirable projected area [ as opposed to / a long side is a part which functions in order to carry out re-outgoing radiation of the re-incident light reflected by the circular polarization of light detached core, when it considers as polarization light equipment, and / the outgoing radiation side of a long side from this point ] -- 5 or more times of that of a shorter side side -- especially -- ten to 100 times -- it is

[0062] The configuration of the one side of a vertical side or the both sides which prepares the prism-like irregularity of a light guide plate may be determined suitably. As preferably described above, the opposite side edge section is thin-shape-ized rather than plane of incidence as an inclined plane. In that case, the configuration of an inclined plane may be determined as arbitration and can be made into a proper field configuration like a straight-line side or a curved surface. When it is not a straight-line side, it is more desirable than the point which equalizes the direction of outgoing radiation of the outgoing radiation light from an outgoing radiation side that it is in the range of less than 5 times from whenever [ average tilt-angle ] in the total location of the field in which prism-like irregularity is prepared.

[0063] The configuration of prism-like irregularity to establish does not need to be formed on a straight-line-like slant face, either, and may be formed on the slant face including a refracting interface, a curve side, etc. Moreover, neither unevenness nor its configuration of heights or a crevice needs to be the same in the whole prism-like concave convex, and its structure where the configuration and include angle change from an incidence side gradually is more desirable than the point of obtaining the outgoing radiation light which is excellent in perpendicularity.

[0064] The pitch of the heights in a prism-like concave convex or a crevice is so desirable that it is smaller than points, such as control of light-and-darkness nonuniformity, and prevention of moire with a liquid crystal cell, since outgoing radiation light is usually emitted in the shape of a stripe through the heights or crevice. 500 micrometers or less especially of 300 micrometers or less of periods of the desirable heights in consideration of manufacture precision etc. or a crevice are 5-200 micrometers above all. In addition, a period becomes more nearly deficient in productive efficiency than points, such as manufacture precision, in less than 5 micrometers, and interference and distribution by diffraction increase and it becomes unsuitable for the back light for liquid crystal displays.

[0065] Moreover, as for the above-mentioned long side in the slant face which forms heights or a crevice, it is desirable that the tilt angle to the outgoing radiation side is especially 2 or less times 5 or less times above all 0 to 10 degrees. By considering as the range of this tilt angle, based on the tilt angle of the long side concerned, it is reflected in an outgoing radiation side at a more nearly parallel include angle, and incidence is carried out to a shorter side side, it is reflected [ incidence is carried out to a long side and it is reflected, and ] in it in that case, and the light transmitted at a larger include angle than the tilt angle concerned carries out outgoing radiation from an outgoing radiation side.

[0066] The aforementioned result, -izing of the angle of incidence of the light which carries out incidence to a shorter side side can be carried out [ fixed ], the variation in angle of reflection can be controlled, and YukimitsuTaira-ization of outgoing radiation light can be achieved. Therefore, by adjusting the tilt angle concerned of the long side in the slant face which forms heights or a crevice, and a shorter side side, directivity can be given to outgoing radiation light and it becomes possible to carry out outgoing radiation of the light at a perpendicular direction thru/or the include angle near it to an outgoing radiation side by that cause.

[0067] In the light guide plate which incidentally consists of acrylic resin, the maximum angle of the light to which end-face incident light is transmitted based on the refractive index (about 1.5) is 41.8 degrees, and the maximum angle of the light to which the refractive index of a light guide plate follows on increasing, and is transmitted becomes small. Therefore, the transmission light which the rate of the transmission light which the rate of projected area to the outgoing radiation side of a long side decreases, and can control the direction of outgoing radiation through a long side if the tilt angle of said long side exceeds 10 degrees fell, and carried out incidence to the shorter side side via the long side, The variation in angle of reflection with the transmission light which carried out direct incidence to the shorter side side becomes large, and the controllability which forms outgoing radiation light into Yukimitsu Taira falls, and it becomes scarce at the directivity of outgoing radiation light. In addition, although the tilt angle of the long side concerned becomes disadvantageous for parallel-izing of outgoing radiation light at 0 times, it approves in this invention.

[0068] As for the above-mentioned shorter side side in the slant face which forms heights or a crevice on the other hand, it is desirable that the tilt angle to the outgoing radiation side is 30 degrees or more above all 25 to 50 degrees. By considering as the range of this tilt angle, the transmission light which carries out incidence through direct or a long side can be reflected in a perpendicular or the include angle near it to an outgoing radiation side through the shorter side side, and outgoing radiation of the light of a direction which acts effective in improvement in the visibility of a liquid crystal display etc. can be carried out efficiently.

[0069] About the configuration of the plane of incidence in a light guide plate, there is especially no limitation and it may be determined suitably. Generally, although it considers as a perpendicular field to an outgoing radiation side, improvement in the rate of incident light can also be stretched, for example as a configuration according to the periphery of the light sources, such as a curve concave, etc. Moreover, it can also consider as the plane-of-incidence structure of having the induction which intervenes between the light sources etc. The induction can be made into a proper configuration according to the light source etc. In addition, although the configuration of an outgoing radiation side has a common flat side etc., it can also prepare detailed prism-like irregularity if needed, and can also establish a diffusion layer. Furthermore, a circular polarization of light detached core can also be directly prepared in the outgoing radiation side of a light guide plate.

[0070] A light guide plate can be formed with the proper ingredient which shows it transparency according to the wavelength field of the light source. Incidentally what shows transparency in [ wavelength ] about 400-700nm is raised in a light region like the transparence resin represented with the acrylic resin like polymethylmethacrylate, a polycarbonate and the polycarbonate system resin like a polycarbonate polystyrene copolymer, epoxy system resin, etc., for example, glass, etc.

[0071] A light guide plate may be formed by the proper approach. As the manufacture approach more desirable than points, such as mass-production nature For example, the approach of filling

up thru/or casting and carrying out polymerization of the liquefied resin which can carry out polymerization to the mold which can form predetermined prism-like irregularity with heat, ultraviolet rays thru/or a radiation, etc., Approaches, such as injection molding with which the metal mold which can fabricate the resin made to fluidize through the approach of pushing thermoplastics against the bottom of heating to the metal mold which can form predetermined prism-like irregularity, and imprinting a configuration, the thermoplastics which carried out heating melting, or heat and a solvent in a predetermined configuration is filled up, etc. are raised.

[0072] The light guide plate does not need to be formed as a like and may be formed as layered product of dissimilar material etc. and according to one sort of ingredients one-single layer material, although the sheet for prism-like concave convex formation was pasted up on the light guide section which bears transmission of light. In the above-mentioned light guide plate, the property of the angular distribution of outgoing radiation light, field internal division cloth, etc. can be adjusted based on control of the surface ratio of a shorter side side and a long side, the configuration of a tilt angle and a prism-like concave convex, curvature, etc.

[0073] Incidentally, a refractive index is the inclined plane where a prism-like concave convex does not have curvature by 1.5, and, in the case of the light guide plate in which initial outgoing radiation light carries out outgoing radiation perpendicularly, re-outgoing radiation of the re-incident light which minded the circular polarization of light detached core by making the tilt angle to the outgoing radiation side of a long side into 6.6 or less degrees can be carried out by include-angle change of less than 10 degrees. Moreover, when a prism-like concave convex has curvature in that case, re-outgoing radiation of the re-incident light concerned can be carried out by include-angle change of less than 10 degrees by having at a rate more than the predetermined area which described above the part from which the tilt angle concerned becomes 6.6 or less degrees.

[0074] Size of a light guide plate, magnitude of the light source, etc. by the purpose of use can determine the thickness of a light guide plate suitably. Especially the general thickness of the light guide plate in the case of using for a liquid crystal display etc. is 0.5-8mm 0.1-10mm above all 20mm or less based on the plane of incidence.

[0075] the opposed face of the outgoing radiation side of a light guide plate -- like the example of drawing -- the need -- responding -- a reflecting layer 41 -- a metallic reflective layer can be arranged preferably. This reflecting layer prevents generating of the leakage light from the opposed face concerned, is effective in improvement in outgoing radiation effectiveness, and functions as a polarization conversion means of polarization light equipment. You may unite with the opposed face concerned, and a reflecting layer is piled up as a reflective sheet etc., and can take a proper arrangement gestalt in this invention.

[0076] According to the reflecting layer which consists of a metal in the above, reflex time can be made to reverse a polarization property efficiently, and the case where it is based on the total reflection and diffuse reflection the polarization conversion efficiency minded the interface of a refractive-index difference is excelled. When the circular polarization of light incidentally carries out incidence in general at right angles to a metal side, the conversion efficiency of right and left of the circular polarization of light serves as about 100% of value, and shows 90% or more of conversion efficiency even in 30 incident angles.

[0077] A metallic reflective layer more desirable than the point of polarization conversion efficiency has a metal side containing at least one sort of the metal of a high reflection factor which consists of aluminum, silver, gold, copper, or chromium. The metallic reflective layer

which is excellent in adhesion with the opposed face of the outgoing radiation side of a light guide plate can be formed as the mixing coating layer of the metal powder by binder resin, an attachment layer of the metal thin film by a vacuum evaporation method etc., etc. The metallic reflective layer may be formed as a multilayer interference thin film etc., and can also prepare the proper coat layer aiming at improvement in a reflection factor, antioxidizing, etc. in the one side or both sides if needed.

[0078] In addition, about a reflecting layer, it can replace with the aforementioned reflecting layer 41, or a reflecting plate can also be formed along with the opposed face of the outgoing radiation side of a light guide plate with the reflecting layer. The method which forms a reflecting plate in the opposed face concerned of a light guide plate has the advantage which can make small the re-outgoing radiation angle of the re-incident light through a circular polarization of light detached core, when the tilt angle of a long side is the same. About the reflecting plate, it can apply to the aforementioned reflecting layer correspondingly, and the reflecting plate which has a metallic reflection side can use preferably. Therefore, as a reflecting plate, proper things, such as a resin sheet which attached the metal thin film, and a metallic foil, a metal plate, can be used. The front face of a reflecting plate does not make it indispensable to be a mirror plane, but, on the whole, may be formed in homogeneity as two or more pages, a continuation curved surface, etc. of a small include angle.

[0079] Moreover, the thing of less than 5 times has above all the half width of the half-value width of the breadth of the angle of reflection of the reflected light at the time of carrying out incidence of the parallel light more desirable as a reflecting plate than the point which controls the breadth of re-outgoing radiation light less than 10 degrees. Therefore, as a reflecting plate, a reflection factor is high and the breadth of angle of reflection can use a small proper thing. It has a rough front face by irregularity, a reduction roll, etc., and you may make it the angle of reflection of the reflected light spread a little.

[0080] According to the above-mentioned light guide plate, various equipments, such as a liquid crystal display which can carry out outgoing radiation of the light made parallel with high precision using it in the direction which is excellent in perpendicularity advantageous to a check by looking, and can obtain the polarization light equipment which is excellent in brightness, using the light from the light source efficiently, as a result is excellent in low-power nature it is bright and legible, can be formed. In addition, as a light guide plate, a match can use [ the wavelength region of the outgoing radiation light based on it, and the wavelength region of light which a circular polarization of light detached core reflects as the circular polarization of light besides predetermined ] preferably as much as possible.

[0081] The back light of a side light mold is formed like the example of drawing by arranging the light source 42 to the plane of incidence of a light guide plate usually. Although a thing proper as the light source can be used, array objects, such as the shape of the point light source of the linear light source of a cathode-ray tube etc., light emitting diode, etc., its line, or a field, etc. can use preferably, for example (cold, heat). On the occasion of formation of the back light concerned, it can also consider as the combination object which has arranged proper auxiliary means, such as the light source holder 43 which surrounds the light source in order to lead the emission light from a linear light source to the side face of a light guide plate like the example of drawing if needed, and a prism sheet for the outgoing radiation directional control of light.

[0082] In addition, generally as a light source holder, a resin sheet, a metallic foil, etc. which attached the high reflection factor metal thin film are used. When pasting up a light source holder on the edge of a light guide plate through adhesives etc., formation of prism-like irregularity can

also be omitted about a part for the jointing. Moreover, a light source holder can be installed in the predetermined side of a light guide plate, and it can also be made to serve as a reflecting plate.

[0083] The light guide plate which can be preferably used for formation of polarization light equipment While the directivity is made to carry out outgoing radiation of the incident light from a side face from an outgoing radiation side at high effectiveness, and the outgoing radiation light excels [ directivity ] in high directivity and perpendicularity [ as opposed to an outgoing radiation side above all ] is shown Reflection repeats the re-incident light which it excelled in the re-outgoing radiation effectiveness of the re-incident light through a circular polarization of light detached core, and the directivity of the re-outgoing radiation light and an outgoing radiation include angle were as much as possible in agreement with the directivity of initial outgoing radiation light, and an outgoing radiation include angle, and minded the circular polarization of light detached core, and it is made to carry out outgoing radiation with a small reflective number of cycles above all that there is nothing.

[0084] The polarization light equipment by this invention changes the outgoing radiation light into the optical condition which contains a linearly polarized light component richly through a phase contrast layer etc. if needed, a polarizing plate is made easy to penetrate, and it prevents [ a reflective loss etc. is prevented by reusing the reflected light (re-incident light) by the circular polarization of light detached core as an outgoing radiation light by polarization conversion, ] an absorption loss, and enables it to aim at improvement in efficiency for light utilization as mentioned above. Although the quantity of the quantity of light which penetrates a polarizing plate ideally may be increased twice [ about ] with this method, it is more desirable than the point used as the light source that the linearly polarized light component which may penetrate a polarizing plate is included 70% or more above all 65% or more.

[0085] Like the above, it can be excellent in the use effectiveness of light, and the polarization light equipment by this invention is bright, and it can excel in perpendicularity, and light with little light-and-darkness nonuniformity can be offered, and it can use it for various equipments preferably as a back light system in a liquid crystal display etc. from large-area-izing etc. being easy.

[0086] The liquid crystal display 6 which used the polarization light equipment 5 by this invention for the back light system at drawing 5 was illustrated. For a lower polarizing plate and 62, a liquid crystal cell and 63 are [ 61 / an upper polarizing plate and 64 ] the diffusion plates for compensation. The lower polarizing plate 61 and the diffusion plate 64 for compensation are formed if needed.

[0087] A liquid crystal display is formed by generally assembling suitably component parts, such as a driving gear of accompanying in the liquid crystal cell and it which function as a liquid crystal shutter, a polarizing plate, a back light, and a phase contrast plate for compensation as occasion demands, etc. In this invention, except for the point using the above-mentioned polarization light equipment, there is especially no limitation and it can be formed according to the former. Especially, the liquid crystal display of a direct viewing type can be formed preferably.

[0088] Therefore, there is especially no limitation about the liquid crystal cell to be used, and a proper thing can be used. Although it is used in favor of what displays above all by carrying out incidence of the light of a polarization condition to a liquid crystal cell, for example, can use for the liquid crystal cell using a twist nematic liquid crystal or a super twist nematic liquid crystal etc. preferably, the liquid crystal and dichromatic dye of a non-twisting system can be used for

the liquid crystal cell using the liquid crystal of the guest host system distributed in liquid crystal, or a ferroelectric liquid crystal etc. There is especially no limitation also about the drive method of liquid crystal.

[0089] In addition, the liquid crystal display which used what has high degree of polarization is more desirable than especially the point of obtaining the display of the good contrast ratio by the incidence of the advanced linearly polarized light, as a polarizing plate by the side of a back light as a polarizing plate like the absorption mold linearly polarized light child of for example, an iodine system or a color system etc. On the occasion of formation of a liquid crystal display, proper optical layers, such as a diffusion plate formed, for example on the polarizing plate by the side of a check by looking, an anti glare layer, an antireflection film and a protective layer, a guard plate, or a phase contrast plate for compensation formed between a liquid crystal cell and a polarizing plate, can be arranged suitably.

[0090] The aforementioned phase contrast plate for compensation aims at compensating the wavelength dependency of a birefringence etc. and aiming at improvement in visibility etc. In this invention, it is arranged if needed between the polarizing plate by the side of a check by looking or/and a back light, and a liquid crystal cell etc. In addition, as a phase contrast plate for compensation, a proper thing can be used according to a wavelength region etc., and it may be formed as a superposition layer more than one layer or two-layer. The phase contrast plate for compensation can be obtained as an oriented film of instantiation etc. with the above-mentioned phase contrast plate for linearly polarized light conversion.

[0091] in this invention, laminating unification is carried out on the whole or partially, and the optical element thru/or components which forms the above-mentioned polarization light equipment and a liquid crystal display fixes -- having -- \*\*\*\* -- separation -- you may arrange in the easy condition. On the occasion of formation of a liquid crystal display etc., the outgoing radiation light which is excellent in perpendicularity or Yukimitsu Taira nature is supplied, the re-incident light through a circular polarization of light detached core is also in a condition with little the loss and include-angle change by dispersion etc., and the consistency of the direction of initial outgoing radiation light improves re-outgoing radiation, and the polarization light equipment which supplies efficiently the outgoing radiation light of a direction effective in improvement in visibility can use preferably.